THE ENGINEER.

Machine Tools and their Use in Locomotive Works.

MACHINE TOOLS AND THEIR USE IN LOCOMOTIVE WORKS.

IN selecting a subject for the present Machine Tool Supplement, we have thought it advisable to depart from our practice hitherto of only describing machines to enter a little into the way in which they are used. We have also thought it might add to the interest, and give a homogeneity to the subject, if the tools employed in a particular kind of factory were taken for discussion. Our reasons for selecting locomotive works

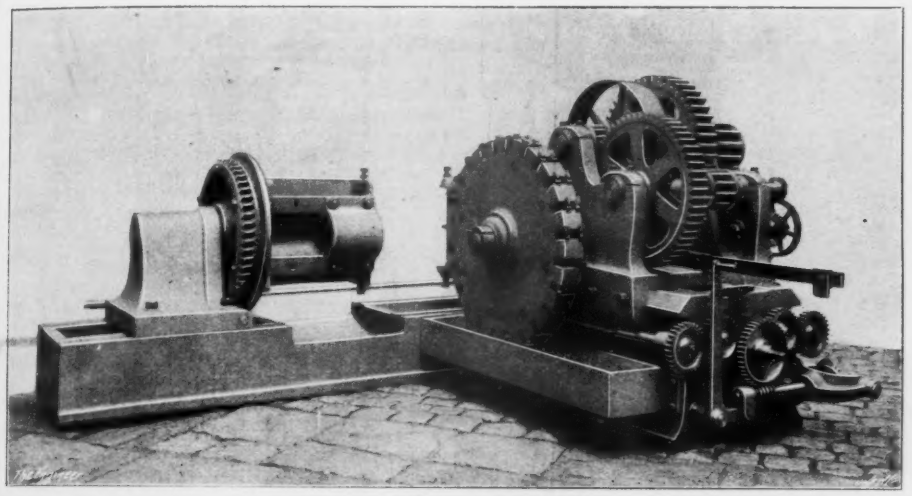

Fig. 1—CRANK SWEEP CUTTING MACHINE

are not far to seek. In the first place, there is probably no class of engineering work more generally popular. The locomotive appeals not only to the trained engineer, but as strongly, in some cases more strongly, to nearly every man, most children, and several women, who have been drawn by one. Secondly, recent events have forcibly directed attention to locomotive building in this country; and finally, locomotive manufacture has so long flourished in England, that to no engineering work has more attention been paid by the machine tool maker. In a sense this statement may require qualification. More special tools have been made for electrical and cycle works than for locomotive works, but those trades are in their infancy compared with locomotive building. You may find in the works of our railway companies now, and we shall illustrate some of them in these pages, tools which were built forty, fifty, sixty years ago, and are but little worse to-day than when first they were erected.

The design of these machines, moreover, is in most cases a thing to be proud of. There is no lack of surface or material, no idea of making machines with limited life, no thought that in ten years or twenty years they would be out dated. The machines were designed as well as ever they could be designed, and made as well as it was possible to make them, and with the exception of such parts as must in the nature of things wear out, there is no reason to suppose that they will not be as good fifty years hence as they are to-day. In many places such machines have been subjected to modern conditions, they have been speeded up and modified in other ways, and they are at least as good to-day as many modern tools. But, apart from the machines themselves, there are a hundred-and-one other considerations to be taken into account. It must be remembered that now-a-days locomotives are made by tens and twenties, where in the past they were made by twos and fours. The consequence is, that whereas there would have been then little economy in the construction of expensive rigs and jigs, chucks, and copies, there is now every reason for using as many of them as possible. We shall devote a good deal of space in the succeeding pages to this bearing of the subject.

For the purpose of this Supplement we have visited several works which are mentioned hereafter, and we may take this opportunity of expressing our thanks to the locomotive superintendents of those works for the facilities they have accorded us—to Mr. Holden, Mr. Drummond, Mr. Billinton, Mr. Ivatt, and Mr. Dean. We have had no special reason for selecting these works more than others, and on another occasion it may be our good fortune to visit others of the works of our great companies with a similar object. But we believe that the manufacture of locomotives as carried on by the railway companies of England is fairly represented by the works mentioned. Horwich has hitherto been ahead of other works, but under new management, and with great extensions in progress, Doncaster has come into line with it. The Swindon works are also being extended, and in a smaller way Brighton and Nine Elms are to follow, whilst Stratford, labouring under the difficulties of a small dividend, is making the machinery it has dance to a more lively tune than ever before, and adding new machines as rapidly as it may. To Mr. Holden in particular we must express our thanks for some exceedingly valuable comparative figures showing the advantage of modern methods of machining. These will be found in their appointed place in the following pages.

We have not attempted, indeed it would have been almost as hopeless as inadvisable, to draw comparisons between the methods employed by different managers. Without a complete and intimate knowledge of all the conditions—to be acquired only by years of acquaintance—comparisons are more likely to be misleading than helpful. We have therefore adopted no particular arrangement in the following pages beyond giving the notes on each works together, and introducing, as far as seems suitable, descriptions and illustrations of the more noticeable machines.

We have not deemed it advisable to follow the machining of locomotive parts from end to end. It would be impossible in such a case to avoid the detailing of many things that are mere common-places to the majority of our readers. We have rather sought out things peculiar and exceptional for illustration and description, feeling confident that such things as show particular ingenuity or novelty are more likely to be acceptable than accounts of operations and tools which any capable mechanical engineer may have had ample opportunity for studying.

GREAT WESTERN WORKS, SWINDON.

We give the place of honour in these pages to Swindon, because, in the first place, the annals of the Great Western Railway command more respect than those of any other railway in the world; and, secondly, because the works at Swindon are now amongst the largest in this country, and when the new shops, of which the buildings are practically complete, is in operation, will be, it is said, the largest locomotive works in the world. It should, however, be borne in mind that at Swindon a great deal more is done than locomotive building. Hydraulic machinery for all parts of the Great Western system is made and maintained there. It makes its own electric machinery, its own cranes, and does its own building, so that the manufacture and repair of locomotives, although it holds a good first place, is far from occupying the whole attention of the great works. We shall, however, turn our attention only to engine building, and shall discuss a few methods of machining which are followed.

Among the most interesting special machines at Swindon a remarkably fine set of tools for finishing crank pins must be mentioned. These machines were constructed by Craven Brothers, and are illustrated on this page. The crank shaft is mounted between centres much in the usual way for turning pins, but in place of the ordinary fixed tool, a heavy and powerful disc carrying a large number of round-ended tools in pairs revolves and advances in such a way as to first cut out the crank webs, which have been roughed out in the forging, and then by successive stages to reduce the crank pin to octagonal form. Finally, the crank pin is allowed to revolve at the same time as the cutter, and the pin is roughed out to a circular form. It must be remembered that the forgings come in in a very rough condition. The only approach to the formation of a pin being a large rectangular notch cut out of the block of metal from which the webs are finally shaped. When one sweep is milled out and the pins rounded, the crank is turned end to end in the centre headstocks, and the other sweep presented to the milling cutters and dealt with in the same way. The bed has planed T-bolt slots, with recess to clear the crank sweep not being milled. The driving headstock is mounted upon a strong slide bed fitted with steel cutter spindle of large diameter running in adjustable conical bearings. The cutting tools are inserted in such a way as to cover the whole width of the gap. The milling head is mounted on a cast iron centre driven by treble purchase spur gearing and driving pulley; this headstock

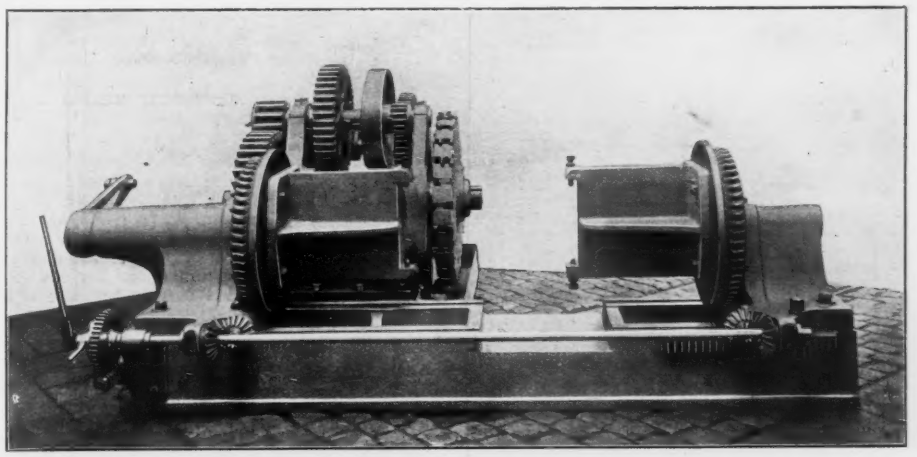

Fig. 2—CRANK SWEEP CUTTING MACHINE

has self-driving motion to feed the milling cutters into the crank sweep to the required depth, and automatic knock-out to stop the traverse when the cutters are the required depth. The centre headstocks for holding the crank are fitted with special chucks; the left-hand headstock is provided with adjustable balancing arm to balance the crank and give steady rotation; the right-hand headstock is adjustable along the bed by rack and pinion to suit different lengths of cranks. These headstocks are geared together with self-acting motions to revolve the

crank, to round the pin after the sweep is cut to the required depth. The machine is driven by an overhead counter-shaft. Both pins being done, the shaft is next put into a crank-pin turning machine, in which the shaft is held whilst the tool revolves, and is there finished. This method is quicker, and gives a truer pin than when turned in a lathe, because there is both freedom from spring in the shaft itself and in the long tool which is necessary to clear the webs. The crank being fixed and the cutting tool revolving round the pin, makes it perfectly cylindrical and in true line with the shaft part, and when the headstock is set to the length of stroke required, all the cranks will be of the same length of centres. The

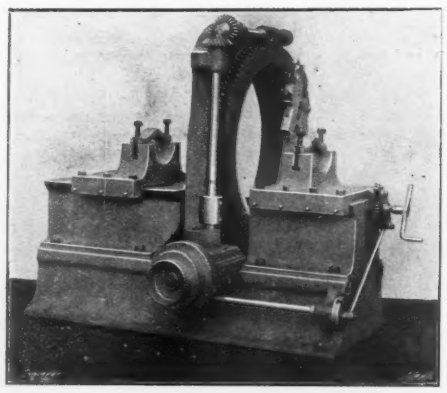

Fig. 3—CRANK PIN TURNING MACHINE

main bed has slides to carry the driving headstock and planed T-bolt slots, to which are bolted two supplementary beds for carrying the chucks for holding the crank, which are self-acting in slides in either direction, and with quick hand adjustment. The driving headstock is fitted with a revolving ring carrying the tool rest to work within the crank sweep, adjustable to put on the cut for various diameters of crank pins, with self-acting down feed. This headstock is adjustable in slides by a screw with accurate divisions to suit the different centres of crank pins; the revolving ring is driven by a worm wheel and two worms geared together by mitre wheels on a vertical shaft gearing into mitre wheels on worm shafts, each of which is provided with arrangement for taking the end thrust of the worms.

At Swindon a method very similar to that employed at Stratford, to be described later, is used for the manufacture of piston rings, but as one or two special arrangements have been adopted, it will not be without interest to follow the machining of a set of rings from beginning to end. The machine used is a Richards horizontal lathe with a turret for the tools. There are two of these machines under the care of one workman. For all practical purposes they and their outfit are identical. We therefore write only of one. The turret carries four tool bars. The first bears on its end a roller for centering the work, and a tool for cleaning the top edge of the casting; the second has a pair of tools for rough turning and boring; the third a pair for fine turning and boring; and the last, tools for parting and rounding. In Fig. 4, the arrangement of the head is shown quite roughly. The casting to be worked upon is a cylinder about ⅜in. thick by 12in. deep, and up to 18in. diameter. Three lugs for bolts, with holes through them are cast on one end. This piece is put on the table of the Richards lathe and bolted down loosely by the three lugs. The roller A in operation 1 is then, by moving the

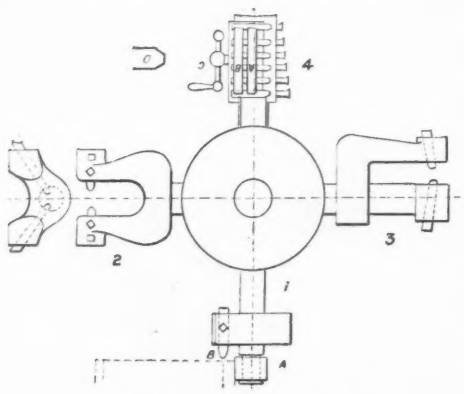

Fig. 4—PISTON-RING TOOLS

turret on the cross slide, made to bear against the outside of the cylinder, which, whilst it revolves, slides on the table till it is touching the roller at its three highest points. A few seconds is enough to do this. The work is then bolted down, additional bolts being run into the ⊥ grooves between the lugs to keep it quite steady. The tool B, operation 1, is then run across the top edge, as shown by the dotted lines, and cleans it up. Operation 2 is then commenced. The two tools shown, rough machine the inside and outside simultaneously. The tool carrier shown has been made specially for this job. It is all in one part, and, whilst not so applicable for other jobs as the other form of tool holder shown for operation 3, it is, being in one part, stiffer and more suitable for roughing down. Operation 3 is done in the same manner. These tools leave about 6in. of the cast iron cylinder truly turned and bored; the next operation is to part them off. A gang tool is used for this purpose. It carries six knives, the top one protruding more than the second and so to the last. The object of sloping them thus is that only one ring shall be parted off at a time. It will be readily seen that it would be practically impossible to part all the rings off simultaneously. The uppermost tool just skins the top face of the casting already turned, the other five cut into it. On the side of this gang tool-box is mounted a little slide, capable of movement by the handle C. Six small tools are clamped to it by the bars A and B. These tools are shown enlarged at D. When all the parting tools are fairly entered, the operator brings these little tools into play. They enter the grooves already cut, and with their bevelled edges round off the corners of the rings. They are kept in for a couple of revolutions or so. As the parting tools work further and further in, the rings are removed one by one from the top. Taken altogether this is as complete an arrangement for turning rings as we have seen.

Various methods of making copper fire-box stays are in use at Swindon. The stay most largely used is 5in. long, 1in. diameter, screwed 1¼in. at each end, and reduced in the middle portion. Several automatic lathes are doing this work. The method of performing it on a Cleveland auto-

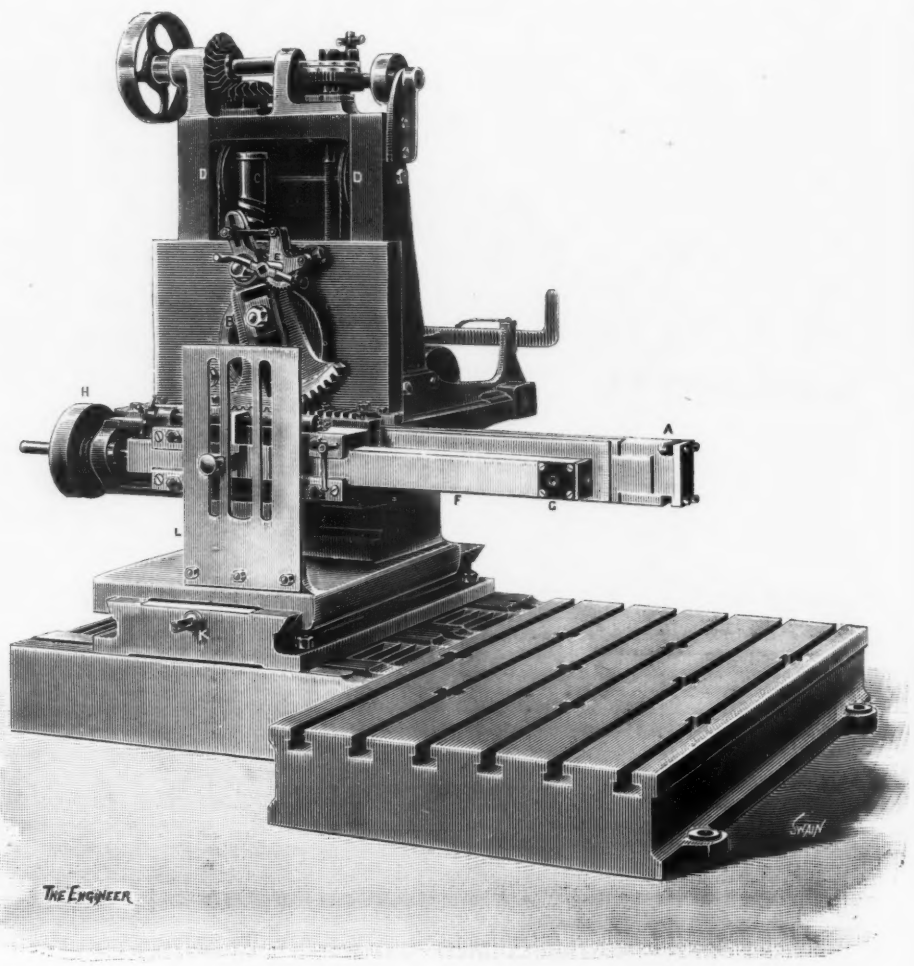

Fig. 7—PORT MILLING AND VALVE FACE PLANING MACHINE

matic is interesting. The stock is fed through the head in the usual way. The turning tools are fitted in the end of a stout tube, bored to the diameter of the finished stay. For a short distance near the front end, where the tools are mounted, this tube is complete; but for the rest of its length the bottom half is cut away. The object of this is as follows. When the turning tool has cut about 1¾in., a tool 2½in. broad, but sharply bevelled, is fed

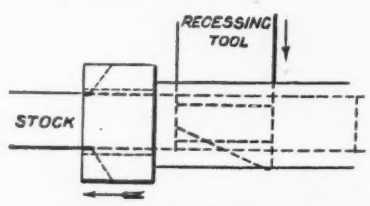

Fig. 5—TURNING COPPER STAYS

straight across under the work in such a way as to reduce the middle 2in. to the smaller diameter. Possibly Fig. 5, may make this clearer. This view is taken looking down on the work from above. The arrows show the direction of movement of the turning and recessing tools. The object of the half tube is now seen. In the first place, it allows the recessing tool to attack the work underneath, and in the second place it prevents the work from being thrust upwards by this tool. The turning and recessing being complete, the stay has to be screwed. Again a tubular tool is used. Its end is divided into three parts, and being tapped, suitably bevelled inside, and provided with a ring outside, it forms a screwing die. This runs up and screws the first 1¼in. of the stay up

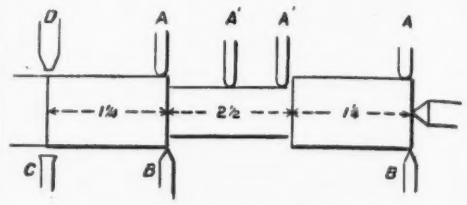

Fig. 6—SCREWING STAYS

to the recessed part, but slightly before it commences work on the second screwed part, the first screwed part has entered a nut fixed inside the tubular tool. Thus it is ensured that the two parts of the thread are cut on one continuous spiral, and there will be no strain on them when they are screwed through the two plates. The dies are then screwed off, and the stay parted by a tool on a cross slide.

This is a very pretty way of turning out stays, but it takes about three minutes twenty seconds to make a stay, and it is desired to reduce the time considerably. A set of tools to do the work on a lathe is therefore being made at the works. The foreman in charge of this turnery very courteously showed us his sketches for this tool, and such parts of it as were already complete, but as some alterations were being made, we did not have an opportunity of seeing it at work. The principle of it will be understood readily from Fig. 6. The first operation is to run the stock forward. Then three rollers mounted on the turret run along it and take out any kinks, and at the same time it is centred. The turret is swung round to bring the back centre mounted in it in position. On the saddle of the lathe is mounted a cross slide, carrying in all six tools, four, A, A^1, A^1, A, for turning, and two, B and B, for chasing. The first four are behind the work and cut upside down. The stock being run out and centred, the four back tools are advanced until A^1 and A^1 have entered to the depth of the recess, and A and A have cut to the right diameter for the screwed portion. The carriage is then moved 1½in. sideways, and the four tools being in operation the stay is turned all over by this amount of movement. The slide is then returned, the chasers B and B run up, and the nut dropped into the lead screw, and the threads on the two ends cut simultaneously. The cutting-off tool is mounted in a lever, which can be lifted out of the way when not required; opposite to it in the same lever is the bevel tool D, which cleans off the last thread

MILLING AND PROFILING MACHINE

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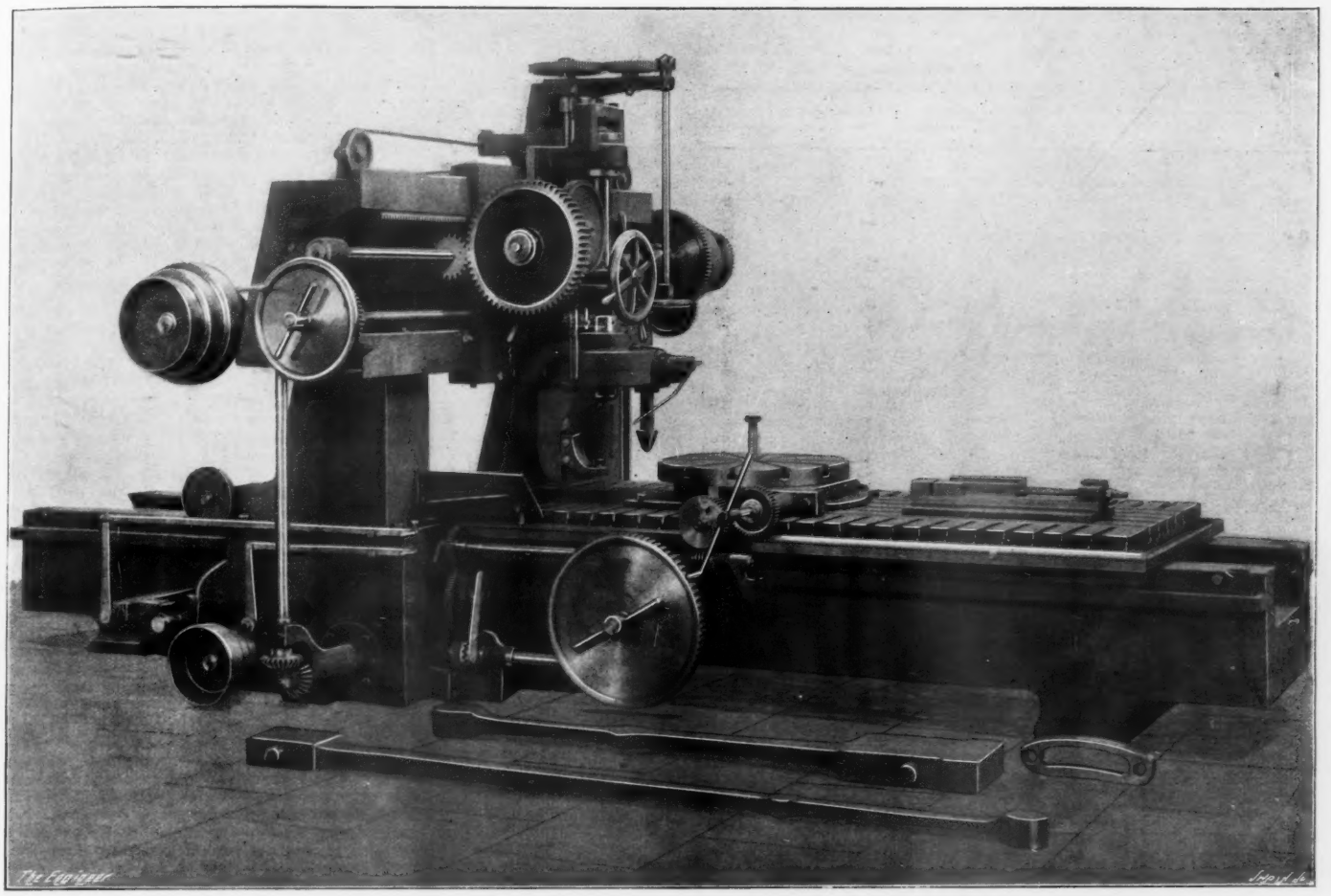


and so saves hand work on it. It cuts upside down, and is put into operation for a moment before the final parting off. It is expected that with this whole arrangement it will be possible to turn out a stay in a little more than two minutes, which will certainly be an excellent result.

Of automatic machines of all makes there is a large number at Swindon. There are several Jones and Lamson, one at least of which is fitted up like that at Doncaster, described below, for turning roof stays, the two die boxes being mounted, as shown in the sketch, with the exception that in order to accommodate stays of different lengths the swinging die box is mounted in a slide on the arm. At the time of our visit, stays about 21in. long were being turned, the time taken being approximately ten minutes each. Several Herbert lathes are also in use, and are thought highly of for the heavier class of work. One of these was at work on long pins, possibly 1¼in. diameter, being turned down from 2in. bar. It is found advisable not to reduce to the finish diameter at one cut, although it is admitted that this could be done readily enough. The reason is interesting. In turning down big gun barrels or shafts, it is well known that if too much material is taken off at each cut the relief of the strains in the outer parts of the material causes the shaft or barrel to bend and twist. It is said that the same thing happens if it is attempted to reduce these pins at one cut to finished size, starting from the free end, no back centre being used. When about two-thirds of the work is turned, the free end is seen to be revolving considerably out of truth. It is possible to get over this difficulty by cutting in the opposite direction, that is to say, by notching near the chuck end and cutting towards the free end; but the notching absorbs all the time saved, and it is questionable if the work is so good. This is an interesting point as showing secondary limitations imposed by the nature of material on the dimensions of a cut.

As we have not come across it elsewhere, except at Seebohm and Dieckstahl's own works, it may be mentioned that an air blast is being used with great success at Swindon for cooling any of the air-hardened steels. It was first suggested by the Sheffield firm mentioned, who had some of their Capital steel on trial at Swindon. A job on which Mushet had not been altogether successful was offered for test. At first the new steel was not up to the work, but the representative of the makers then took the tool to the smith's fire, and brought it up to a temperature far beyond that usual for tool steel—indeed, till the thin part of the tool was on the point of fusing—he then subjected it to a blast from the air laid on for the pneumatic tools. This cooled it comparatively rapidly, and when it was ground—without any special precaution as to angles—it did the work satisfactorily. Since that an air blast has been fitted beside the tool smith's hearth. The air is brought through iron pipe to a small nozzle, through which it is directed on the point of the tool resting on supports in a sheet iron tray. Not only can Mushet be hardened better by this method than by merely allowing it to cool, but as it is cool enough to handle in from ten to fifteen minutes, instead of requiring half a morning, no little time is saved.

Of jigs and rigs for special work there is a fair number at Swindon. A pretty little jig for drilling the cotter holes

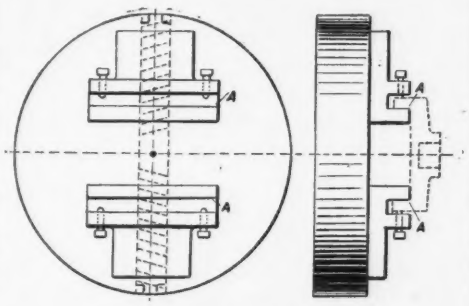


Fig. 8—SLIPPER CHUCK

in brake screws may be mentioned, because it has a self-centering arrangement, two sets of wedges, which is rather unusual. But it is among chucks that most features of interest are to be found. In Fig. 8 is shown

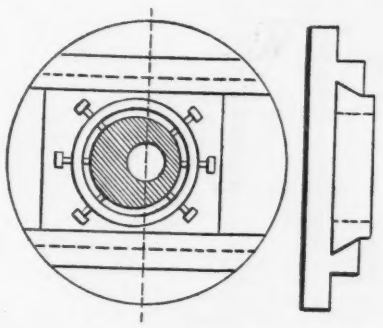


Fig. 9—SHEAVE CHUCK

roughly a chuck used for boring and facing crosshead slippers. There are two jaws mounted on a face plate, and movable by a right and left-handed screw. The side elevation shows the shape of the jaws and the end of a slipper, dotted. The slippers are planed on the slide face before turning, and they are centred in this chuck by the faces A A. All that the operator has to do is to set them endways, and a little variation in this direction is of no moment. When they are finally adjusted, four clamping screws practically make the work and the jaws, the jaws and the face plate, one, and there is no danger of any motion of the slipper.

Another interesting chuck is used for facing and boring excentrics. It is shown by Fig. 9, in which the excentric being bored is shaded. The excentric is held by clamping screws in a hole in a plate, which can be slid across the face plate so that any desired amount of excentricity may be given. When the hole has been bored the plate is run back again till the disc is centred, and it is then faced without the waste of time which is inevitable if it is faced whilst revolving about the shaft centre.

For trueing up the side-rod crank pins a machine like a quartering machine is used, but in place of the boring bars a tool fitted excentrically in a revolving box is used. The wheels on their axles being placed properly in

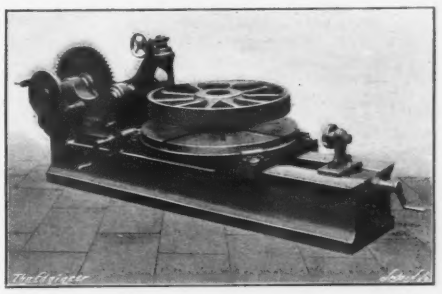


Fig. 10—WHEEL CENTRE SLOTTING MACHINE

position, the two pins are scraped at once, the tool going round and round them and advancing. The side rods are, of course, re-bushed to suit the reduced diameter of the pins.

Whilst on the matter of wheels and axles, it might be mentioned that case-hardening of journals appears to have been superseded pretty generally by rolling. Whilst they are in the lathe in which they have been turned, a tool consisting of a hard steel roller, some 4in. or so diameter, mounted at the end of a stout bar, is caused to press against them and travel backwards and forwards. The face of the roller is very slightly convex. The effect is much the same as that of rails upon tires, and compressed the fibres and increased the endurance of the steel. Ground journals, we gather, have been a failure for the peculiar fact that whilst they will run cool enough

in one direction, they rapidly get hot if run the opposite way.

An interesting tool, which may be new to some of our readers, though it was invented before cast steel wheels were known, is Mr. F. W. Webb's curvilinear wheel slotting machine, as made by Sharp, Stewart and Co. The illustration of it shows practically all that there is to show. It consists of a long bed, upon which a revolving table for carrying the wheel to be machined is mounted. At one end an arm is pivoted, and by means of a slotted link and die and adjustable crank, is given a rocking motion. It carries a tool box, rotatable so that the

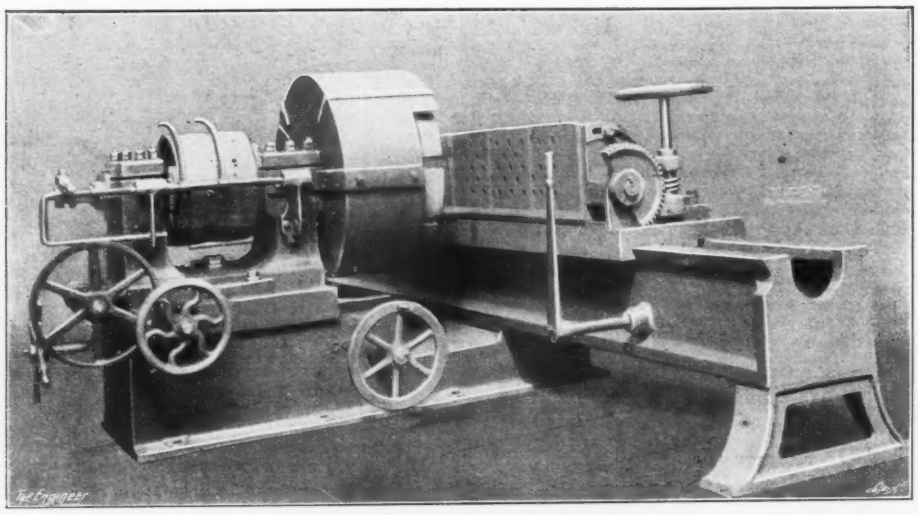


Fig. 11—TASKER GRINDING MACHINE

corners of the spokes can be worked; the tool makes a curved stroke and cleans up the inside of the wheel rim. Wheels up to 8ft. diameter by 5in. wide can be cleaned up on this machine.

GREAT NORTHERN WORKS, DONCASTER.

There are at the present time, probably, no better organised railway company's works in this country than those of the Great Northern at Doncaster. We say this with the full knowledge that part of the works is old, and has been only in part revised. But very large additions are being made, and the whole place is undergoing, by degrees, complete reorganisation, under the active superintendence of Mr. H. A. Ivatt, the company's locomotive engineer, and his chief assistant, Mr. D. Earle Marsh. A large area of land, behind, so to speak, the present buildings, has been acquired, and several very large shops have already been erected, and are at present working either partially or up to their full capacity. There are views, too, with regard to further extensions, the ends of some of the shops being only of wood, so that addition may readily be made. The principal building is a fine erecting shop, with a capacity on the pits for 100 engines, divided up into bays, each devoted, as far as possible, to a particular trade, and separated from its neighbours. Thus, one is for fitting, another for turning, others for erecting, and so on. New engines are not treated here. The shop is for old engines returned for overhaul or repair. They are arranged in groups of six, their numbers and classes, and the dates on which the engines came into the shop, being painted up over them on the walls; each group is under the care of a chargeman, who has a staff of trained hands under him, to re-erect the engines. Before being handed over to the chargeman the engines are first stripped on incoming pits by another gang. As the parts are taken down they are sent to a wash-house, where they are boiled and cleaned, and then distributed to the various departments for further attention, finally returning to the engine to which they belong. This shop, consisting of numerous bays placed side by side, is organised on the central plan as opposed to the—shall we say?—longitudinal plan at Horwich. We mean that the work from all sides is collected at the centre for redistribution, thus economising labour in movement of material.

The machine tools here do not, generally speaking, present such special characteristics as those in the old works or "factory," as it is now called, to distinguish it from the repair department. They are partly big machines, such as wheel lathes, and in some cases are driven by independent motors. In the old works electricity is only used sparingly; a few tools are fitted with motors to run them at night when the main shafting is idle. But in the new department it is the only power employed. Three sizes of motors are used. They are of 10, 15, and 30 horse-power. In some cases, as we have said, there is one motor to one machine; in others machines are driven in groups off one motor. The power station is at the old works. The same idea of small units obtains there, two sizes of engines, viz., 350 horse-power and 150 horse-power, being used. Thus it is possible to run the engines—Willans type—always at their maximum power and efficiency. Electric cranes serve the new shops—two 35-ton, four motor type, in each locomotive bay, two 8-ton cranes in each of the fitting and machine bays. The big cranes have two lifts, a light and a heavy, and they are geared to travel at a high speed, up to three and a-half miles per hour. The shops are lighted by a zig-zag—not saw tooth—roof with northern lights only, or by electricity, and they are warmed by hot water. The hot water tanks are old Cornish or Lancashire boilers, the head of water is only a few feet, sufficient to promote circulation.

The most surprising thing about the Doncaster machine shops is the great pace at which the tools are run. At Paris an American firm showed steel cutting steel at 120ft. per min., and since then many makers have been seeing what they can do. At Doncaster they say that Mushet and ordinary tool steel has not yet been tried to its uttermost elsewhere. Here they use it regularly at 120ft. per min., and occasionally up to 150ft. per minute, and it stands excellently. Of course the cut is not heavy. It is where a lot of metal has to be taken off in a short time that the new steels pay, but there is not much of that class of work at the Great Northern works. However, we have not come across any other works where Mushet or ordinary tool steel is used to such advantage. There are two secrets in its use. First—and first by a long way—the cutting angle of the tools; and, secondly, the nature of the lubricant and its quantity. The correctness of the former is easily maintained by any one of the tool grinding machines which are for some reason or another not made in this country; the second is secured—at Doncaster—by supplying a proper lubricant as far as possible through pipes laid on to the lathes, and in which sufficient pressure is maintained to provide a copious supply. There is thus no excuse for not using sufficient. The nature of the lubricant we were not given, but we were told that part of the secret is to have the water soft.

Whilst discussing tool steel, it will be interesting to mention the milling cutters used at Doncaster. A good deal of milling is done, although, as we shall have to show presently, there are jobs which it has been found better to do in other ways. Many of the cutters used are made out of axle steel, either bits of old axles or odd ends. They are turned up to size and shape, then the flutes or channels are cut in them, and the spiral groove for breaking the cutting edge up into numerous separate teeth turned. They are then case-hardened, and when ground are as ready for work and quite as good at it as tool steel cutters, and far cheaper. The case-hardening appears to embrace the whole of each tooth, for it is the general experience that the tool is hard enough to work properly till the teeth are so reduced that new cutting is required. Some cutters made in this way are as much as 8in. diameter by 12in. long. These milling cutters run at a high rate of speed. We timed, quite roughly, a couple of jobs side by side. Both were milling steel, one profiling the end of coupling rods, the other at work on a group of bars. The cutter for the latter was, by eye, about 6in. diameter by 10in. long. It made fifty-two revolutions per minute, and the feed was ¾in. in the same time. In the other case, the cutter was 2¼in. to 2¾in. diameter. It made something like seventy revolutions per minute.

To get these speeds the line shafting of the shops has been geared up a good deal higher than it was of yore. We are speaking of the factory, the old works, now. This gives an air of quickness to the whole shop, and both men and boys appear to enter into it and work their tools for all they are worth. Many of the machine men are very skilful, and, being thoroughly acquainted with one tool, they are able to work it to its full capacity. In many cases several tools are under the charge of one man, occasionally of one boy. A considerable proportion of the work is piecework; the prices are arranged with regard to the facilities provided, the intention being that they shall be fair average prices, not subjected to continual cutting, so that a man who shows extra ability or ingenuity shall be able to reap the benefit on pay-day.

There is, of course, a lot of repetition work of the ordinary kind. Warner and Swasey, Herbert, and Jones and Lamson automatics work side by side, and each one possesses some merit which makes it superior to the others for a particular class of work. In some cases they are, so to speak, complementary to each other. Thus, for example, the tools for the Warner and Swasey soon become too short by grinding, then the Herbert very accommodatingly takes them and wears them out. There is nothing very special about most of the work done on this class of tool. It is very much of the kind that most of our readers have had ample opportunity of seeing done many times at exhibitions and shows, but in some cases special alterations of an interesting nature have been made to adapt the tool for particular work. Thus on one of the flat turret lathes a supplementary die box has been mounted to fit it for screwing roof stays. This is quite roughly indicated by Fig. 12. Here A represents the ordinary self-opening die box mounted on the turret, whilst B shows a supernumerary box on an arm centred on the saddle, so that it can be swung into position when required. The roof stay is something like 12in. to 15in. long, and about 1in. diameter. The middle part is reduced, and 3in. at each end is screwed; of course if the screws did not start simultaneously the stay could not be driven through both plates without straining. This neat arrangement removes any danger of that sort, and increases the rate of output of the machine. We are informed that this device was first designed and fitted by Alfred Herberts to a lathe of their own make.

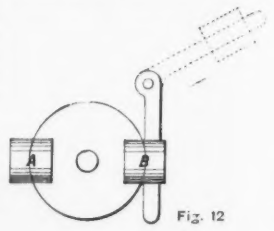


Fig. 12

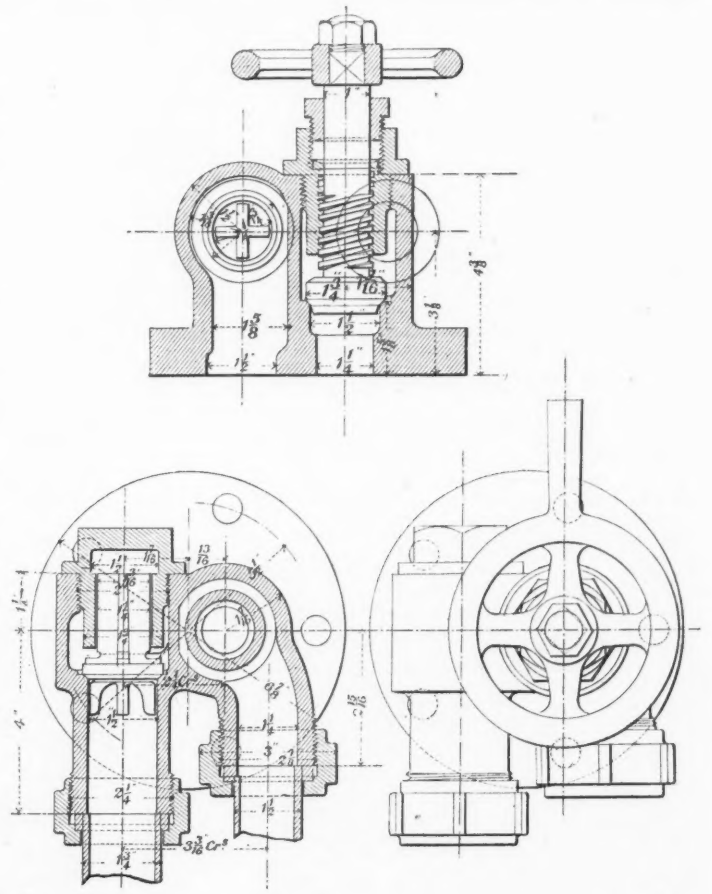


Fig. 13—FEED CHECK VALVE BOX

A capital example of a special fitment for a lathe is afforded by a device employed for turning and screwing feed check valve boxes as illustrated by Fig. 13. The lathe is peculiar. It was made by Muir, but has been considerably modified. In the first place, the whole head with its overhead gear can be raised

or lowered. In the second place, the tool is fixed in the face plate, the work is bolted to the saddle. Query, is it a lathe at all? The tool can be moved towards the centre for facing by a star and tappet; for turning, boring, and screwing the spindle and tool moves towards the work. A rough sketch, Fig. 14, shows the construction of the chuck. It consists first of a plate which is bolted firmly to the saddle. On top of this is a circular plate with two pillars, a cross piece, a screw, and a hand wheel. This plate can be revolved round its centre, and has four notches for quartering properly. A little locating pin moved by an excentric holds it at any one of its four positions. The work is indicated at A clamped in position. The face of the flange has been machined in a previous operation. The work is so disposed that the two pillars do not interfere, and all four vertical faces can be machined if desired, the holes bored and screwed, and the valve seats turned. Both operations are done on the same machine, a whole lot of first operations being completed before the second operation is commenced.

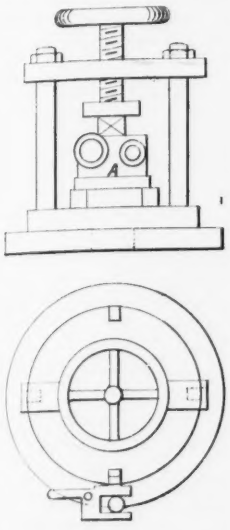


Fig. 14

Some interesting time-saving arrangements for milling may be noticed. The side rods for Great Northern locomotives like those of the London and South-Western, are not of I section, but are rectangular throughout. They are, however, bellied both ways, a good deal in the vertical plane, but only slightly in the other direction. The greater bellying is done to a former, on the milling machine, or when forged near enough the edges are merely ground. The lesser bellying is effected very simply, without any special fitting. The rod is fixed on the table of the milling machine flat side uppermost; it is supported only at the ends, but under its centre a block is fixed. This block is of such height that it allows the rod to spring downwards under the pressure of the cutter something like $\frac{1}{8}$in. in a matter of 5ft. or so. The rods being machined on both sides, a total bellying of $\frac{1}{4}$in. is secured without any difficulty. It may possibly be worth observing that the very fact that the side rods can be machined in this way shows the advantage claimed for the plain section, that is that its flexibility is a desirable quality, obviating the chance of fracture and reducing the wear at the pins. Mr. Drummond holds strong views on this matter. Since the flexible side rod has been adopted on South-Western engines there has been practically no trouble in that quarter. He points out that the side rod is to be looked upon and designed as a girder with a vertical load.

Various methods are adopted in different works for finishing ports. Where the cylinders are separate, or where the valves are above, below, or at the side, there is little or no difficulty in using an ordinary planing, slotting, or shaping machine to finish the face, and an ordinary milling machine to clean up the edges of the ports. But when, as in a good deal of modern practice, the cylinders are cast in one with the valve faces between them and a single steam chest, it is evident that a special arrangement is required. Various methods are possible, and more than one machine can be modified readily enough to do the work. A useful machine is, however, specially made for the purpose by Craven Bros. It is used at Doncaster, and at the risk of presenting an old friend we illustrate it on page ii. The machine has, it will be observed, two rams, A and F. The larger of the two carries a slotting tool, and is used for finishing the face. The quadrant B give it the requisite movement. The smaller ram carries at its side near the end a milling cutter *g*, slightly smaller than the width of the port. A former L, an exact duplicate of the valve face, is mounted on the machine, and controls the action of the mill. It will be observed that the exhaust port is included in this former. This is now-a-days never used at Doncaster, as it is considered bad economy to waste time machining an edge which does not matter a jot. That idea is rather indicative of modern tendencies in mechanical engineering. Our grandfathers worked on the principle that thorough work necessitated the planing of both sides of a plank, even if one side was never seen. Now-a-days we only plane the side that shows, and only part of that side if no more is necessary and it is cheaper so to do. Several other cases in point at Doncaster might be cited.

Whilst on the subject of valves an interesting point with regard to the machining of balanced slide valves is worth attention. It shows in a very clear manner a fact mentioned above, that a particular method of machining is some times desirable for other reasons than mere cheapness or convenience. Most of our readers are acquainted with the Richardson balanced slide valves, largely used in France, and now being adopted on Great Northern engines. The Fig. 15 shows quite roughly the idea. Four channels $1\frac{1}{2}$in. deep are cut in the back of the valve, and four bars, arranged in the form of an Oxford frame, fit these grooves, and are kept up against a plate behind the valve by springs, steam is thus excluded from the area of the rectangular space enclosed, and the load on the valve reduced by that amount. The shaded parts in the section show two of these bars cut through. Now it is evident that the steam-tightness of these bars is of great importance. It might seem that the cutting of these grooves was a job to which the milling machine was particularly adapted, yet a milling machine will not make a tight joint, whilst a shaper or planer will. The reason of this is that a succession of minute curved ridges corresponding to the feed of the cutter are made by the mill; all these ridges, with their corresponding channels, open at the upper edge, and offer passages for the steam. If, however, the groove is formed by straight cuts, the grooves and ridges made by the tool are at right angles to the flow of the steam, and act in the same manner as the grooves turned in an indicator piston. It is said that the known excellence of rolled bars for pump and piston-rods is due also in a measure to a similar effect.

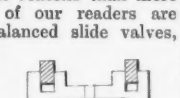


Fig. 15

Another example of the use of a particular kind of tool where another would seem, at first sight, more appropriate, is to be found in the method adopted for making double eyes on the end of brake rods, motion rods, and so on. The ends are forged solid, and we imagine it would be the natural instinct, as it is certainly the practice in many works, to drill a hole and put down two saw cuts to meet it, as a method of removing the central part. It has, however, been found that it is more economical to mill the piece right out with a large devil milling cutter having round-ended teeth. The cutter is the exact width of the slot to be made, and no further machining is required.

Of milling rigs there is, of course, no lack at Doncaster, but the majority of them present nothing particularly out of the way. There are rigs for carrying a couple of connecting-rods or side rods, whilst they are milled to copy on an excellent machine by Muir—see page iii.—but they present no features exclusively belonging to locomotive works. It is unnecessary to do more than illustrate this machine, as not only are Muir's tools very well known, but the engraving is self-explanatory. A few dimensions may, however, be useful. The size of the main table is

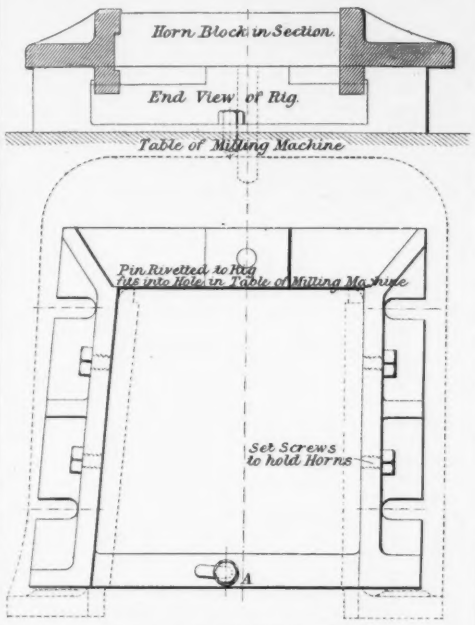

Horn Block in Section
End View of Rig
Table of Milling Machine
Pin Rivetted to Rig
Fits into Hole in Table of Milling Machine
Set Screws to hold Horns
A

Fig. 16—RIG FOR MILLING HORNPLATES

12ft. by 4ft., and the diameter of the circular table is 30in. The length of the bed is 16ft., and objects up to 144in. long, 18in. wide by 5in. deep, may be profiled. The spindle is of hard steel, 4in. diameter. It has a vertical traverse of 12in., and horizontal movement of 4ft. The distance from the under side of the cross slide to the face of the table is 19in. The speeds are such that cutters from 2in. to 18in. diameter may be run at proper rates, and the feed can be varied between $\frac{1}{2}$in. and 3in. per minute.

One interesting case may be described. This is a rig for milling the faces of horn-plates, Fig. 16. The work to be machined is shown dotted. One face is vertical, the other inclined to suit the adjusting wedge. The rig to accommodate this piece is centred on the table of a vertical spindle milling machine by a pin. A slot and pin A in the cross bar at the other end allows it to be placed so that the vertical side can be milled and then by moving to the other end of the slot for the sloping side to be machined.

Grinding is used to a large extent, several ordinary stones being in use, and one special grinding machine by Tasker and Sons, Fig. 11, which is employed for all sorts of facing work, trimming up, angles, channels, and so on, for frameworks and work of a similar kind. The stone is of the cup form, set in segments in the disc. Grit stones have been found to give better results than emery or corundum. The segments of stone are secured by wooden wedges in the disc or drum. Apart from the fact that this is a cheap and economical method of using stone, it is believed that the open spaces and free edges increase the efficiency of cutting. To take up wear and to adjust the cut, the headstock can be moved forwards. It can be also swivelled whilst in operation, so that a new part of the stone may come into action. The table on the bed has an automatic motion to and fro in front of the stone. Besides this rough grinding, a good deal of fine grinding is also done at Doncaster.

Various methods of cutting out side frames are in use in different works. One, say, Crewe, punches them out all round; another, Brighton, drills large holes at the corners and rows of small holes at the curves and slots the straight intermediate parts; or again, as at Doncaster, the whole frame is as far as possible slotted straight out of the solid plate, with only a single hole drilled here and there where the tool cannot start its cut. A very large machine by Fairbairn, Naylor and MacPherson is used. It has three heads. The only preparation on the plates before they are put on it is to planish them and mark ou the top one. The slotting tool is then directed round the curves by the operator. Seven plates, $1\frac{1}{8}$in. thick, are cut at a time. With the straight longitudinal cuts there is, of course, no difficulty or special arrangement required. There is, however, a certain number of diagonal cuts to be made. To meet these each of the three heads is mounted so that it can be swivelled to a certain amount diagonally across the bed. This is managed by mounting each cross slide on a pin at its centre, with a quadrant slot at each end. In addition to this, to allow of the curves being followed the tools are fitted in rotatable tool boxes, one of which is shown by the annexed Fig. 17. The tool fits by its square shank into a circular block, which is revolved as required by a worm and hand wheel.

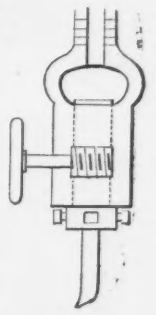


Fig. 17

The same plan is adopted in cutting out motion plates They are cut on another machine ten at a time.

A case of the conversion of a "scrapped" machine at Doncaster may be mentioned. The machine was originally a small slotter, it is now used for tapering boiler tube ferrules. A table under the ram has eight taper holes drilled in it. This table makes an eighth of a revolution at a time. A boy keeps putting ferrules into the holes. They only enter a short way, but as each comes under the ram it is driven right down into the hole and so takes the taper. A kicker underneath at one side throws them out again under a delivery shoot into a basket.

LONDON AND BRIGHTON WORKS, BRIGHTON.

If the London and Brighton Company's shops have less to offer in the way of machine tool work than some other shops, they have probably more of interest to show in the way of historical tools. We make no apology whatever for illustrating machines which are to the modern toolmaker quite out of date. Many old tools are interesting and instructive in themselves, and many as displaying the age of some things which the younger generation is apt to consider particularly its own. Take, for example, the chasing hob on an extension of a lathe spindle, with a rocking shaft at the back, bearing at one end a lead nut to fit the chasing hob, and at the other a tool to do the screw-cutting, both brought into action when required by simply swinging a lever from the back to the front of the lathe and pressing down upon it. A brass-finisher's lathe at Brighton is fitted with that device, and is marked "patented 1854," getting on for fifty years ago.

Or take, again, radial drilling machines. A good many of our younger engineers probably regard the trunnion pattern as being a modern improvement on the cylindrical column design. They could plead justifiable reasons for thinking so and for believing that it originated a few years ago in America. They may find at Brighton machines made to that design, and no whit inferior in proportion or workmanship to our present drilling machines, which were put down very many years ago. It is little hints like these that a man may get by visiting the older established works in this country that go far to confirm him in the opinion that no toolmakers in the world surpass British toolmakers, and that much which is now spoken of as the most modern practice was not new a quarter of a century ago. One is tempted almost to believe that, apart from automatic and semi-automatic tools, there is nothing to be learnt about machine tools which the fathers of some of our older firms did not know. The use of tools is another matter. We use them to-day in a way which would have been astonishing ten years ago; but the fact that the old tools can be used at all under the new conditions is no slight compliment to the makers of them.

Mr. R. J. Billinton has very kindly been to the trouble of having a few of the old machines in his works photographed for us, and has also collected some notes about them. He writes to us that he has also, besides those we illustrate, still at work a slotting machine made by Sharp, Roberts in 1846, and that somewhere down the line there is still in use a planer made by Nasmyth, and worked by a chain. Unless our memory fails us, a modern planing machine worked by a chain, and regarded somewhat as a novelty, was exhibited at the last Paris Exhibition, we believe, by a French firm. The first of the old Brighton machines illustrated—Fig. 18—is still in use in the boiler shop for punching plates; the maker and age are unknown, but it has certainly been constantly at work for fifty years, and would probably be good for another fifty had it not to be removed to make room for new machinery. It will punch plates up to $\frac{3}{4}$in. thick, and at one time had a shears combined with it, but the upper head some years ago broke away and was never replaced; its fly-wheel countershaft and clutch are seen in the engraving, and it will be observed that it is operated by a long lever and a cam. To one of the front bearings a foot step for a swinging jib is bolted.

Another punching and shearing machine is also illustrated—Fig. 19—it is heavier than the other and will punch and shear $\frac{3}{4}$in. plate. It was constructed at the Brighton works in 1852, and the design was copied from a machine at Scott Russell's works. At that time the Brighton Company had no foundry, and the castings were made by Mr. Packman in Brighton. In the centre is a big spur wheel driven by a pinion. The spur wheel shaft carries at each end a cam, one of which operates the shearing, the other the punching head. It may be remarked that this machine has a lever for throwing the punch out of gear,

much as it is done at present, a refinement which the smaller machine lacked, it being necessary with it to throw a clutch on the countershaft to prevent the action of the punch.

A vertical wall drilling machine, purchased in 1847, overhauled some fifteen years ago, and still doing excellent work, is illustrated by Fig. 20. The wall plate looks rather like a monumental tablet, and its independence of the table may be noted. The drill spindle is fed through a long sleeve driven by bevel gear and a three-step cone with back gear. There is hand and self-acting feed, the

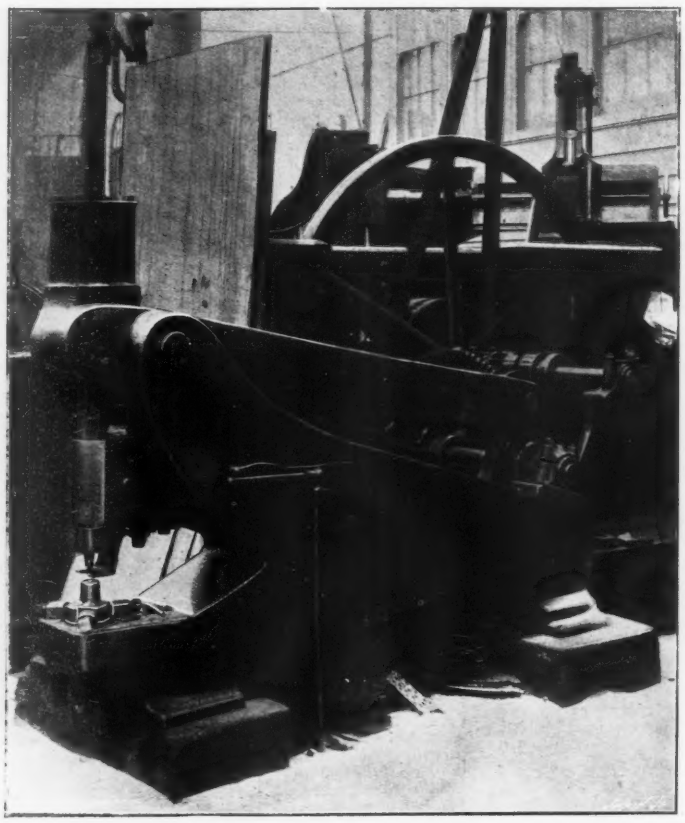


Fig. 18—OLD PUNCHING MACHINE

latter being thrown in or out by a lever which raises or lowers the large spur wheel on the feed shaft, and so puts it in or out of gear with a pinion on the spindle sleeve. The table is raised by gear wheel, rack and pinion. When the machine was altered some fifteen years ago, and a longer feed screw was put in—it has now a stroke of 24in.—wood packing between the table and the wall was removed, as it sprung and caused movement of the table.

The first nut-tapping machine to be used at Brighton was put down in the year 1848; before that all tapping

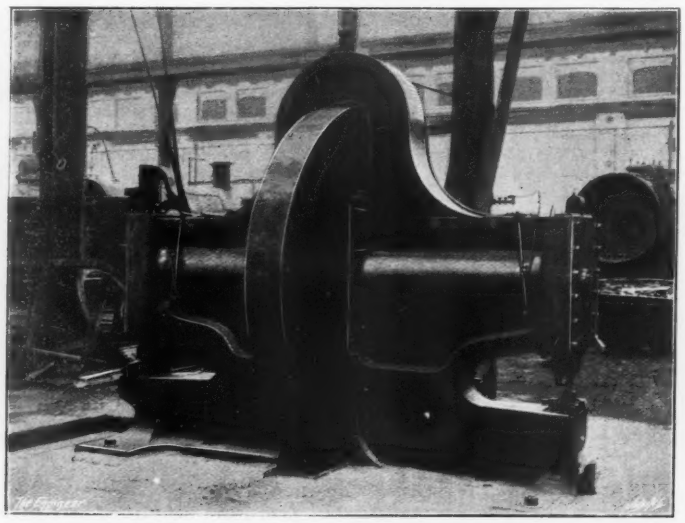


Fig. 19—PUNCHING AND SHEARING MACHINE, 1852

was done by hand. It is probable that this machine, illustrated by Fig. 21, was one of the first of its kind made. This and another machine of the same date are still in daily use in the works. The maker's name is forgotten. The tap fits into the end of a vertical spindle, which is driven by a step cone and gearing in the box which forms the body of the machine. The nut is dropped into a socket at the end of a double-jointed arm, and the spindle is lowered by pressure on a weighted treadle. The long tap having entered the nut, the treadle is let go and the tap works through in the ordinary process of tapping. A constant supply of oil drops on the nut from above. This machine is, we should imagine, the direct lineal progenitor of modern automatic tapping machines, some of which resemble it in several respects.

Looking into these old tools, we think possibly one of the most interesting points to be observed is the strict simplicity and directness of all their mechanism. Complication should be to a mechanical engineer's eyes as odious as a lack of proportion. It is only to be excused when the result more than makes up for the means employed. The tendency in modern machinery is to disregard complication if greater output or greater speed is attained thereby. This is, of course, thoroughly justifiable; but then, on the other hand, cases where unnecessary mechanism is introduced simply and solely for the sake of differing from other people are not unknown. However necessary that may be from a commercial point of view, it can scarcely claim more from the engineer than admiration of the ingenuity displayed, with a proportionate regret for its misapplication.

Lest this slight dissertation on old machines should leave our readers with the impression that there is a lack of new machinery at the Brighton works, we make haste to say that the process of modernisation goes on as fast as may be under the conditions prevailing. The works, roughly triangular in plan, are hemmed in by the railway on either side and the town at the base, so that there is but little possibility of extension. Advantage is being taken of what there is, and a small amount of new ground will soon be absorbed into the works. This will leave room for further improvements, and relieve to a certain amount the present congestion.

Amongst recent tools mention may be made in the first place of a tube plate drilling machine by Kendall and Gent. Two practically identical tools have been recently put down. One of them is illustrated by Fig. 23. It is used for drilling tube plates, and has two spindles 2½in. diameter, with a feed of 12in. The bed is 12ft. long by 5ft. wide between the uprights. The latter are traversed along it by means of racks at the sides, two vertical shafts with pinions engaging the racks and worm wheel, at their upper end driven by worms on a horizontal rod squared at one end to take a handle. The heads are, of course, self-acting

Another tool which is to be found at Brighton, as well as in many, if not all, other locomotive shops, is the pinhole lapping machine, made by Beyer, Peacock and Co., Limited. We have chosen for illustration, p. vii., the latest type of this machine. It will be observed by those who are acquainted with the older pattern that cords, as originally employed, have been replaced by belts: it is found that there is less inconvenience from slipping with these. The machine illustrated, besides this improvement, is an amplification of that at Brighton, for whereas that one only deals with pin-holes and radial links, this machine, besides that work, may be used for slide bars, axle-boxes, and various other similar surfaces, both straight and curved. It is therefore not inappropriately called a universal machine. Our readers are probably more or less conversant with this beautiful tool. For lapping hardened holes a small emery stone—a good deal smaller than the hole to be lapped—is used; it is made to revolve at a high speed by the right-angle strap shown, and at the same time, its spindle being set excentrically in its sleeve, is caused to describe a circle by the rotation of that sleeve, this being effected by a light horizontal belt and worm. At the same time the slide, with the spindle, has a slow up-and-down motion, so that the whole depth and surface of the hole is taken little by little. The effect is the production of the truest possible pin-hole, both as regards diameter, parallelism, and circularity. As this is the latest type of this machine, a few more detailed particulars may be welcome. The amount of excentricity of the orbit of the grinder is regulated by the hand wheel and differential gear at the top of the spindle. The spindle can be revolved at a high speed as shown, or the belt may be slipped on to the larger pulley for slower speed and adjusted by moving the pair of jockey pulleys. Up-and-down motion is given to the spindle by a slotted crank working a counterbalanced lever, or it may be done by a hand lever. The belts are so arranged that this vertical movement does not materially affect their tightness. The adjustment of the hole to be ground truly concentric with the orbit of the grinder is, it is scarcely necessary to observe, of considerable importance. To effect this, transverse adjustment of the headstock by means of two hand wheels, one of which is seen in the engraving, is provided for one direction, whilst the table can be adjusted roughly by the handle to the front of it and finely through worm gearing by the wheel beside the handle.

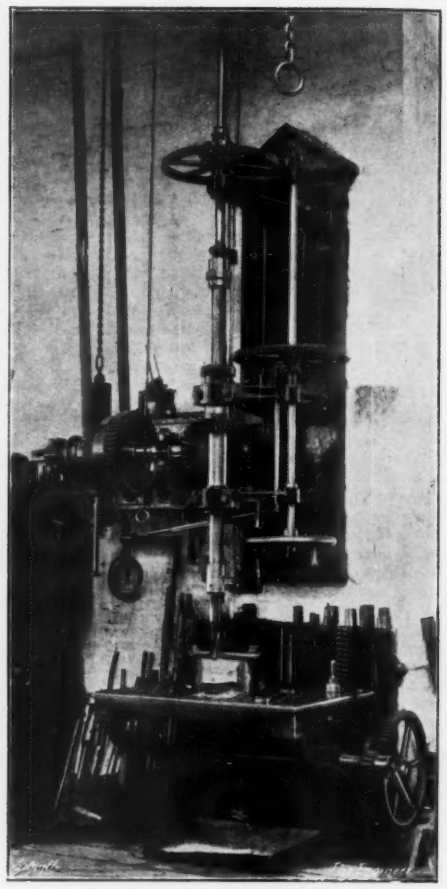


Fig. 20—DRILLING MACHINE, 1847

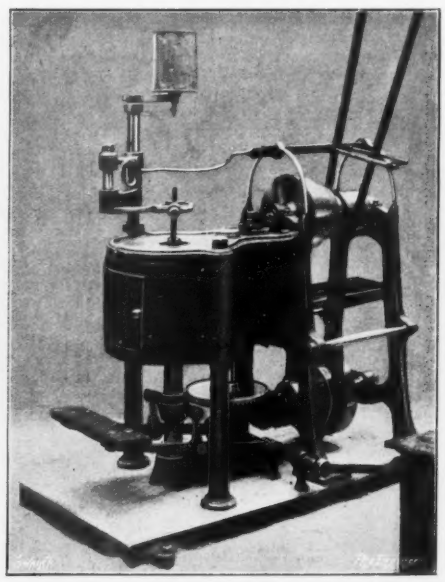


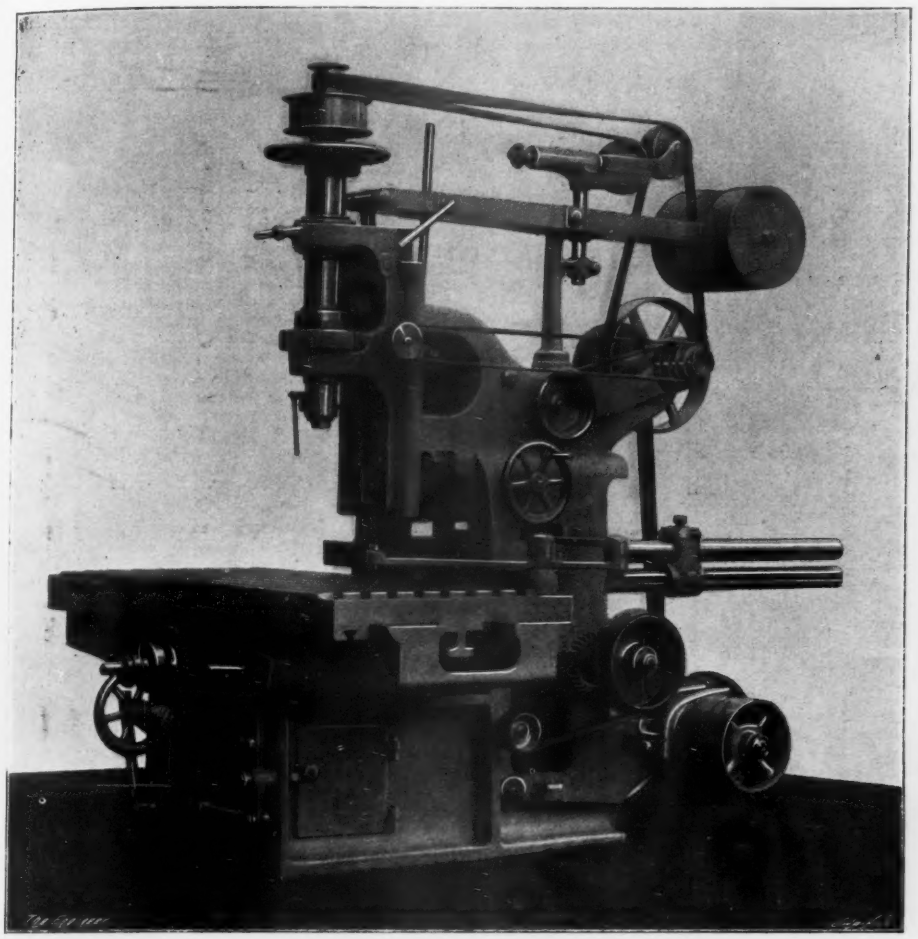
Fig. 21—NUT TAPPING MACHINE, 1848

To gauge the hole the head is raised to allow of the admission of the plug. The feed of the emery wheel is obtained by cautiously increasing the excentricity of its orbit by the use of the hand wheel at the top.

For grinding expansion links and blocks, the grinder spindle is set concentric with the main spindle and a different mandril with adjustable lower bearing fitted. The system of linkage, shown clearly in the engraving, reciprocates a secondary small table to which the work is attached, mounted on the main table. For straight work the supplementary table is guided by vee strips, which fit into grooves in the main table, but for

EMERY LAPPING AND GRINDING MACHINE

BEYER, PEACOCK, AND CO. LIMITED, MANCHESTER, ENGINEERS



curved links and blocks the supplementary table is bolted to the end of the radius rod, the upper rod projecting from the back of the machine in the engraving, the fulcrum on which can be adjusted to give the correct curvature. The feed is effected by moving the headstock towards the work; it must be carefully adjusted not to put too much pressure on the work, or the result will be that it will take longer for accurate work to be obtained, because the springing of the mandril causes the emery stone to enter the hollows instead of working only on the higher places. Provision is also made for grinding slide bars, axle-boxes, and other such work.

LONDON AND SOUTH-WESTERN WORKS, NINE ELMS.

Like most engineering works in London, the locomotive shops of the London and South-Western Railway at Nine Elms are not without marks of antiquity, both in the arrangement and construction of the buildings themselves, and in the tools and appliances they contain. But in the methods of doing work, and in the general management of the shops, Mr. Drummond is as fully alive to modern ways and methods as he is to everything that may tend towards the improvement of the locomotive. We shall describe a few of the special jobs done at Nine Elms, and we are able through Mr. Drummond's courtesy to illustrate from drawings several tools and rigs, &c. The value of small pneumatic hoists was early appreciated for dealing with heavy parts, which required lifting on to benches, machine tools, &c., and these have been fitted throughout the works whenever requirements demanded. The hoists were made in the simplest way imaginable. Suitable lengths of drawn steel tube of the desired diameter were taken, and through them was drawn, by bolt and screw, a short taper mandril. This had the effect of leaving a hard clean surface inside, and no boring was required to make the cup leathers used on the pistons quite air-tight. The ends were, of course, screwed on, and a suitable three-way cock fitted to the lower end. These hoists were rapidly and cheaply made at the works, and are in daily and hourly use.

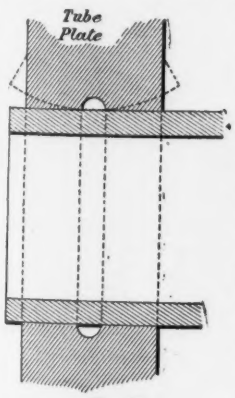


Fig. 22

In order to make sure of the holes for the water tubes in each side of Mr. Drummond's patent fire-box being truly in line and inclined at the same angle, they are bored simultaneously. The fire-box is laid on its side with one template underneath it, that is, on the outside of the box, bolted to it through a few stay holes. Another template is similarly fixed to the underside of the upper side, that is, inside the box, and the boring bar is threaded through the two templates. The cutters are three-tooth trepanning tools cottered to the boring bar. The upper one starts cutting on the outside, the other on the inside, and they are so spaced as to come through practically together. The bar is driven by the spindle of a radial drill. It ought to be mentioned that the templates are kept a little distance away from the plates, so that the tools may pass through freely. The holes having been bored, a groove is cut round each as shown in section by Fig. 22, which also explains the object and action of this groove. Here the dotted lines show, greatly exaggerated, what happens to a plate when a tube is expanded into it. By cutting away part of the centre of the plate by a groove in the manner shown this action is greatly reduced or entirely neutralised, and at the same time the tube appears to enter the groove to the depth of $\frac{1}{100}$in. or so, and thus increases the tightness of the joint. The tool used for cutting the groove can be easily imagined. It is simply a steel plug, which fits the hole. In one side a deep slot or channel is cut, in which lies a stiff steel spring, fashioned at one end into a little cutter which can be thrust outwards by the action of a screw. A collar on the plug provides for its entering the plate to the desired distance.

There are many old tools in the works—excellent machines many of them—some of which have been converted to do special jobs, and others, like the boring machine illustrated on page ix., which are doing the class of work for which they were originally built. This machine was constructed in 1882 by Fairbairn, Kennedy, and Naylor. We do not know that machines of this design are built now-a-days. There is a similar machine, but of smaller size, at Swindon. The base consists of a heavy cast iron column. On each or its four sides there is a vertical slide way, and on each of these a table raised or lowered by a screw entering a pit in the floor. One man attends to the four heads. To the top of this standard a heavy casting with four pairs of arms is firmly bolted. Each pair of arms carries a vertical spindle, projecting some distance through the upper bearing. This projecting part has a feather in it, and a large toothed wheel free to rise and fall on the feather. On the lower part of each wheel is a disc, against the lower face of which bears the upper end of a vertical rod. In the middle of the rod is a hand wheel, and several inches of its lower end are screwed. By turning the hand wheel the rod is raised or lowered in a fixed nut, and the wheel above rises and falls with it. All this is very clearly shown by the illustration. On the summit of the machine there is a cross shaft, driven by the three-step cone, and having keyed to it a bevel pinion driving a large bevel wheel. Both these can be seen partly in the engraving. To the bevel wheel is keyed a pinion which drives an idle wheel on either side. By lowering the wheels on the spindles they are brought into gear with these idlers. The feed is provided for below by raising the tables. Apart altogether from manifest modern objections to the want of individual change of speed for the spindle, and a better arrangement for the feed, it must be admitted that there is not a little in this machine which is worthy of the praise and admiration of modern tool makers. The substantiality of its parts, the width of its faces, the proportions of its gearing, leave absolutely nothing to be desired, whilst the compactness and simplicity, in spite of objections, are things to be proud of. It must be remembered that feeds and speeds were not run to their ultimate limit in the day this machine was built that they are now, and that it was rather the machine tool maker's desire that his machine should live long and work accurately, than that it should be very rapid. That it is well used at Nine Elms is shown by the fact that all the tables are in use. In the front position the method of trepanning out the hole in the big end of the connecting-rod is shown. Three powerful cutters are at work. As one of them, that on the left of the reader, gives the appearance of a taper cutter, it may be remarked

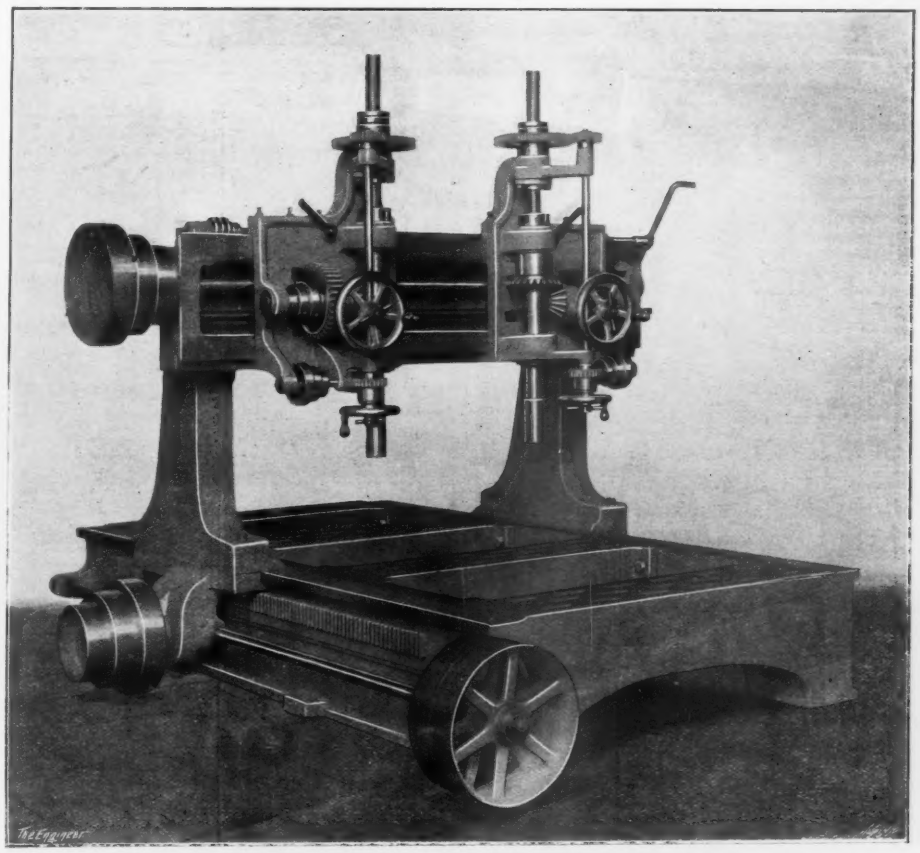


Fig. 23—TWO-SPINDLE PLATE DRILLING MACHINE

TOOLS FOR LOCOMOTIVE WORKS

CRAVEN BROTHERS, LIMITED, MANCHESTER, ENGINEERS

(For description see page xv.*)*

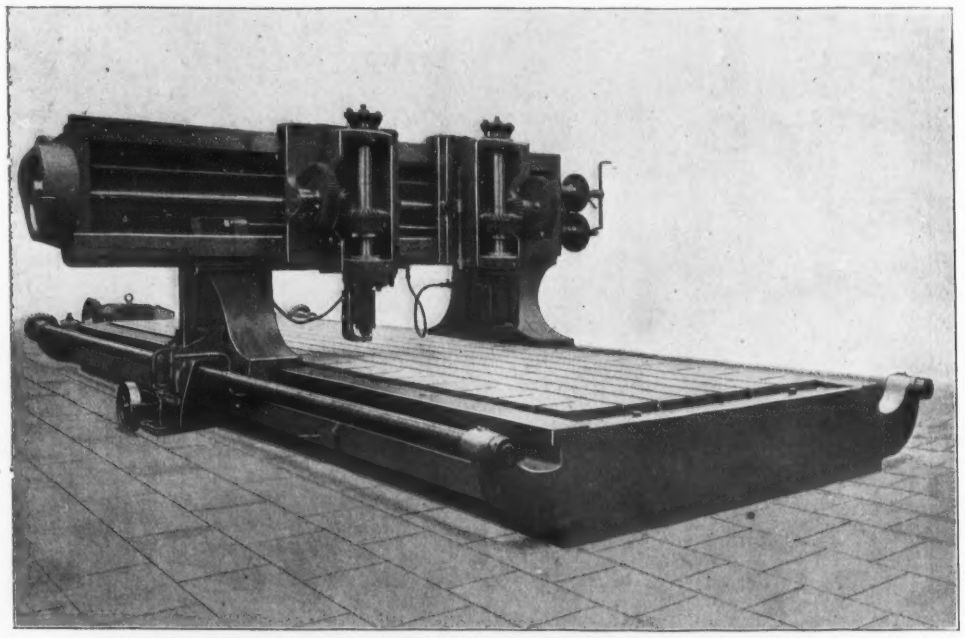


PLATE EDGE MILLING MACHINE—FRONT

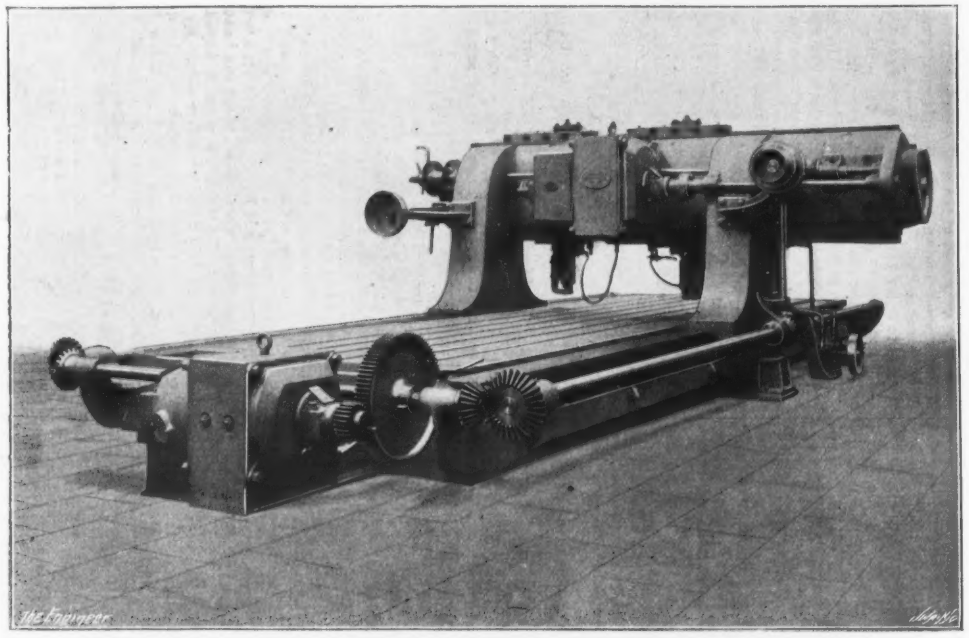
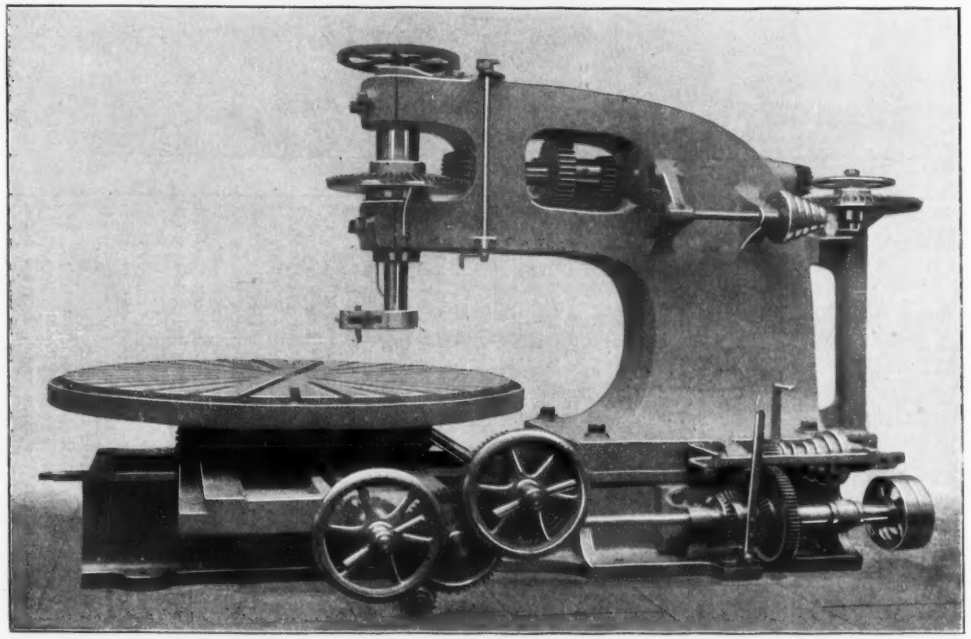
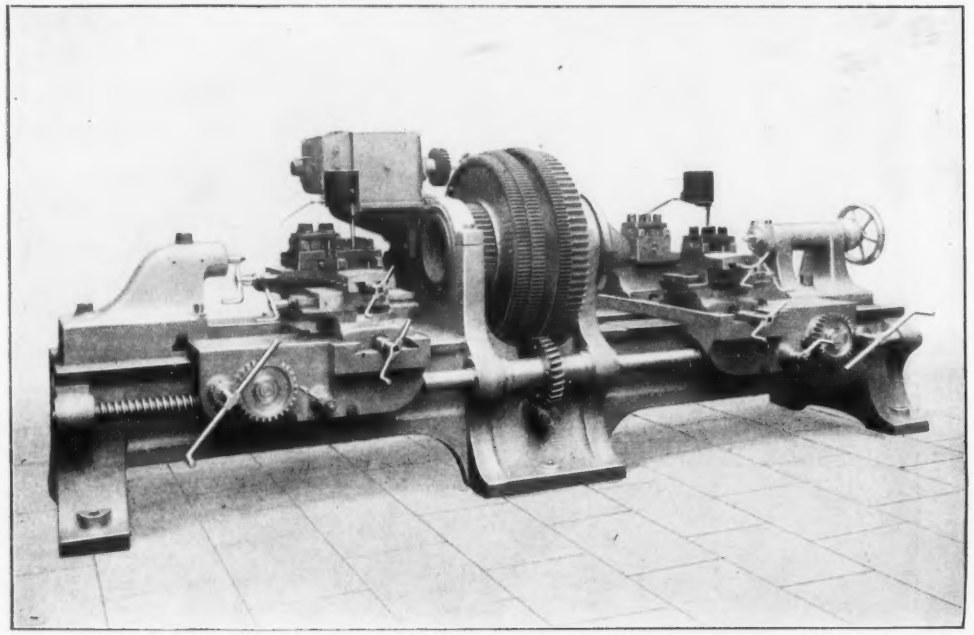


PLATE EDGE MILLING MACHINE—BACK



FLANGE PLATE MILL AND OVAL HOLE CUTTER



DOUBLE AXLE LATHE

that this effect is only due to the way in which the back is worked off the tool to give clearance. A parallel hole is trepanned. From this machine the rod goes to a horizontal drill, where the end is put into a jig, and the two bolt holes bored out simultaneously.

Another example of a tool converted for special work is to be found in the case of an old vertical milling machine, which is now employed almost exclusively for sawing off the edges of flanged plates. This plan is to be strongly commended to those who have not tried it, as it has been found to be far quicker than any other method of dressing the edges. The saw used is of small diameter, and it revolves, of course, in a horizontal plane. The work is mounted on the compound table of the machine, which not only permits of motions at right angles to each other, but also has a rotary motion, so that the rounded ends of flanged tube plates, &c., can be cut off with practically no lost motion. It is scarcely necessary to say that the flanged plates are laid upon their back upon the table, and centred so that their curved ends

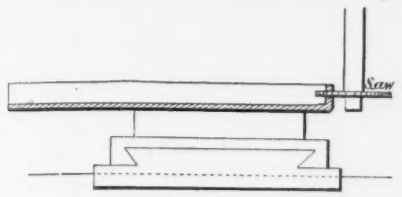


Fig. 24

swing in a true circle; but, to leave no doubt about the arrangement, we give a diagrammatic sketch—Fig. 24—showing a plate in section on the compound table and the saw at work.

But perhaps the most interesting case of a special tool is that used for milling out the motion plates. Mr. Drummond has very kindly lent us drawings of this interesting machine, which are reproduced on page x. Mr. Drummond is a strong believer in cast iron, properly used, and is convinced by experience that no better form of slide has yet been found, at any rate for inside cylinders, than the double cast iron channel pattern. The spectacle or motion plate is also of cast iron, and the tool in question is designed for machining the square trunks or tubes in which the guide bars are bolted, and the valve-rod guides. There is only one standard size of tube plate, so that provision for adjustment is unnecessary, which considerably simplifies the machine.

The headstock and some other parts belonged originally to a small horizontal boring machine. These parts are shown dotted in *Figs. 2 and 4*, page x. In *Fig. 1* the outline of the motion plate is also dotted The work to be done is to mill out simultaneously the two square trunks, K K, for the reception of the guide bars, and to bore two holes on the centres, M M, for the reception of the valve-rod guides. The boring bars, N N, *Fig. 4*, are driven from a wheel fastened on the headstock spindle, whilst two side rods, P P, are driven by a pair of wheels and pinions from the back end of the headstock spindle. Each rod carries a pair of worms, driving the spindles of a pair of milling cutters, shown in detail in the upper part of *Fig. 5*. Both the milling

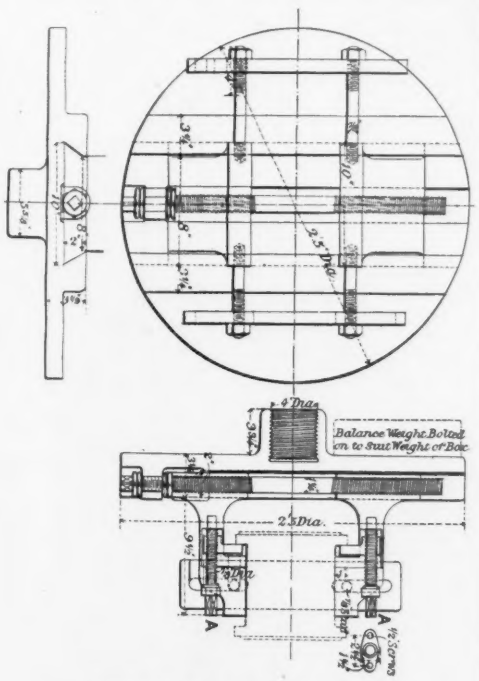


Fig. 25—CHUCK FOR AXLE BRASSES

cutters and the boring tools are fixed, the work being bolted to the table on the knee bracket, and fed forwards. The arrangement of the milling cutters is shown best in the plan, *Fig. 4*, whilst the manner of supporting and driving them is shown clearly in *Fig. 2*. The whole travel of the motion plate is 2ft. 3⅛in. The cast iron bars themselves are planed up true outside, and ground to a good surface inside. They are L shaped in section, the wearing side being much thicker than the other part, which serves only to keep out dirt. Four, arranged to make two channels, go to each cylinder.

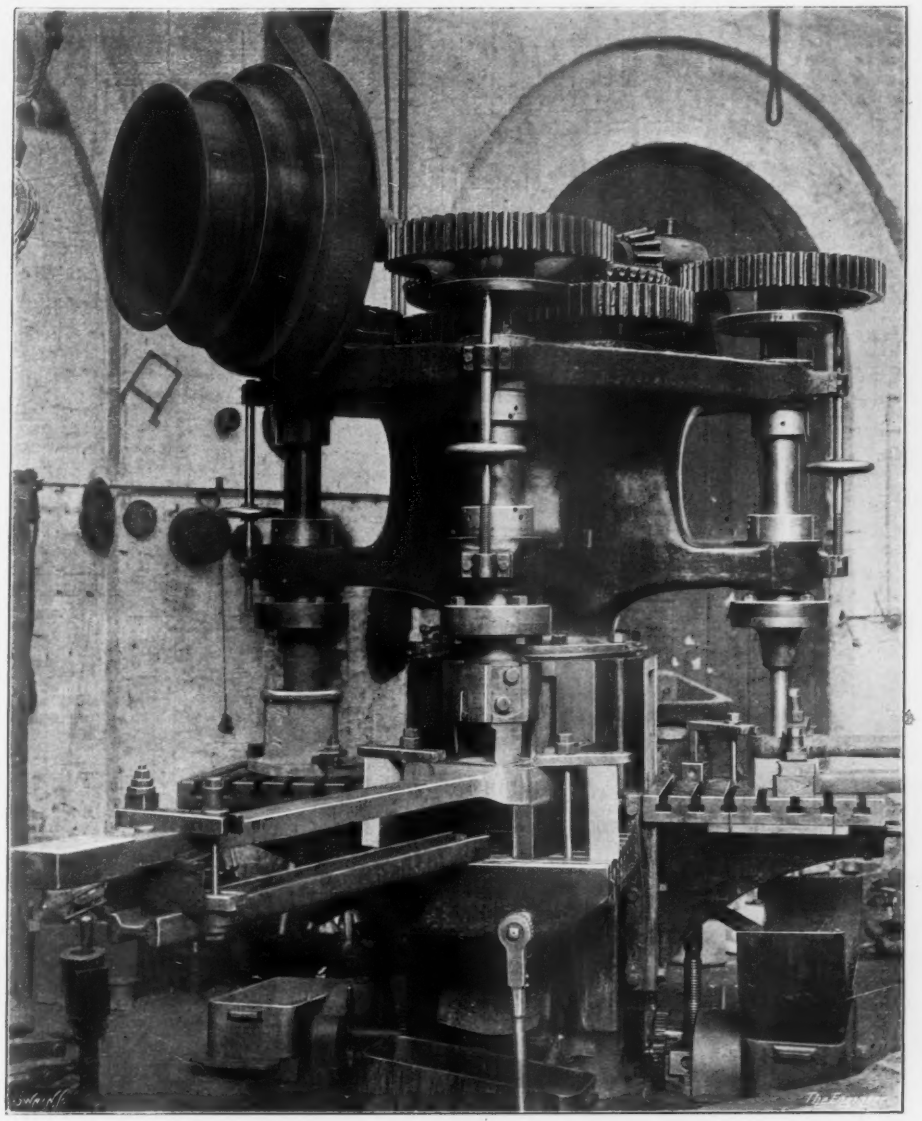
Some useful lathe chucks are to be found in the turning department at Nine Elms. For chucking axle brasses a special pair of slides is fixed on a face plate. They have long flat faces, and can be screwed together so as to clamp the brass between them in the manner shown in Fig. 25, the two screws A A being used to draw the brass firmly down on to packing strips under the opposite flange. The two steel plates assist in holding it endways, and facilitate the act of chucking it.

For machining slipper cross heads a clever special chuck has been devised. It is illustrated by Fig. 26. The object is to bore the hole for the piston-rod perfectly square with the hole for the crosshead pin, and the latter perfectly parallel with the face of the slipper. The chuck consists of a heavy angle plate which can be bolted to the face plate. On it is a revolving table, which can be clamped at any angle, but a locating pin is provided for right angles. A recess in the face of the slipper slides on to a tongue in the table provided for it; so that it cannot get out of square sideways, it is clamped firmly by four bolts. The piston-rod end is then turned and bored. When it is complete the table is turned at right angles, and the holes for the crosshead pin are faced and bored. The drawing shows the proportion of the parts. It should be noticed that the gudgeon of the revolving table is 11in. in diameter, the 2½in. diameter bolt serving only to keep it in place.

Copper stays are used on the London and South-Western locomotives. They are not cut at the sides, but into each end a hole about $\frac{5}{16}$ diameter is drilled. The stays are made from drawn copper bar about $\frac{1}{16}$ larger than finished size. They are sawn off to length, and at each end a cross is cut by a saw for chucking and driving. To avoid any chance of inequalities in the thread, the stays are screwed between dies with a lead screw feeding them at the correct speed. After screwing, the holes in the ends are drilled simultaneously by two horizontal drills opposite each other. In fixing these stays in the boiler after they are screwed in a drift is driven into the holes to expand them, and then a rounding punch of this section gives them a smooth finish. The nose, of course, enters the hole.

Mr. Drummond's fire-box with cross tubes is well known. Opposite the ends of the tubes at each side of the box there is a large rectangular hole, in express engines two holes, cut through the steel box. To strengthen these, and to carry suitable doors for withdrawing or cleaning the tubes, which, by the way, they appear never to require, cast iron frames are riveted to the box. Now the box at this particular part has a double curve, the hole extended over part of the rounded part and part of the flat side of the box. A side view of

FOUR-SPINDLE DRILLING AND BORING MACHINE



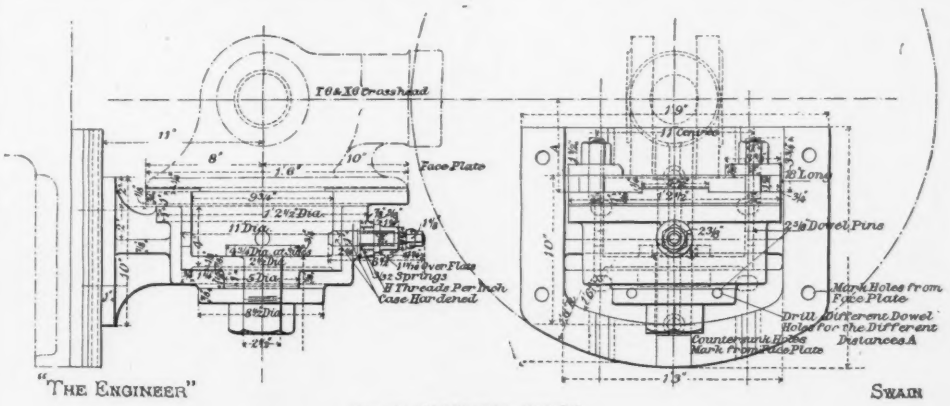

T & X Crosshead
Face Plate
Balance Weight Bolted on to Suit Weight of Box
Mark Holes from Face Plate
Drill Different Dowel Holes for the Different Distances A
Counterbank Holes Mark from Face Plate
"THE ENGINEER"
SWAIN

Fig. 26—CROSSHEAD CHUCK

NINE ELMS WORKS—ARRANGEMENT FOR MACHINING MOTION PLATES

(*For description see page* ix.)

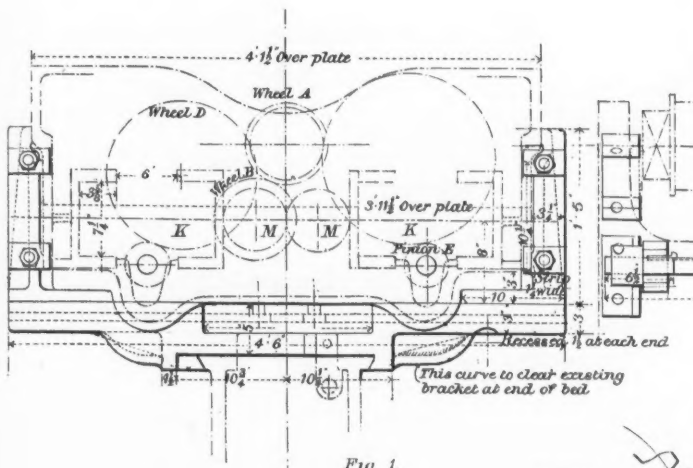


Fig 1.

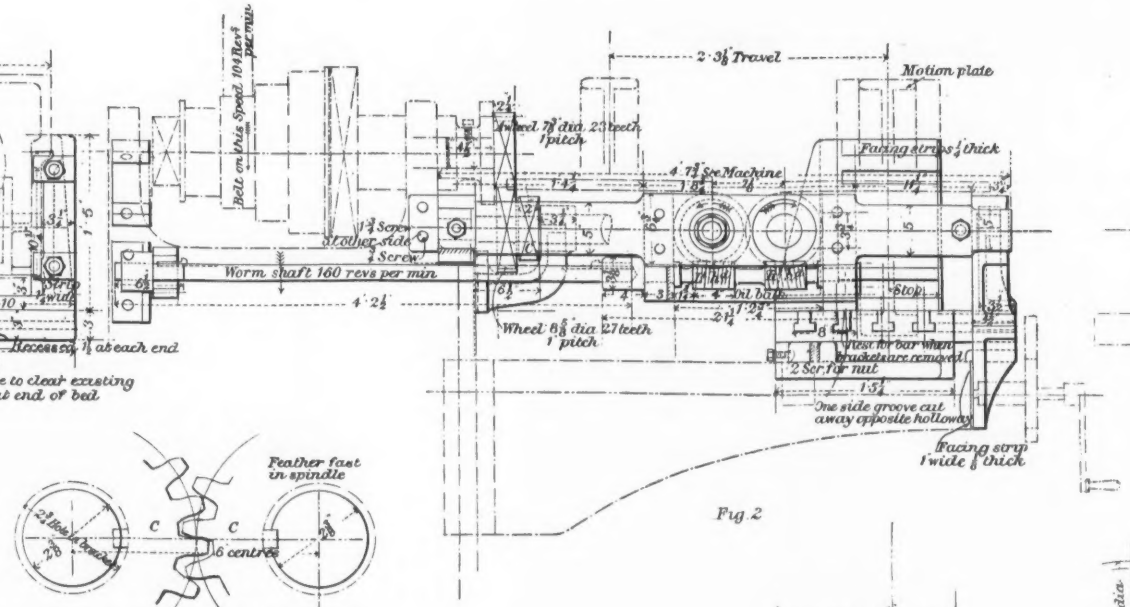

Belt on this Speed. 104 Revs per min.
Worm shaft 160 revs per min
Wheel 7⅞ dia. 23 teeth 1 pitch
Wheel 6⅜ dia 27 teeth 1 pitch
2·3⅜ Travel
Motion plate
Facing strips ¼ thick
Stop
Test bar when bracket are removed
2 Set for nut
One side groove cut away opposite hollow
Facing strip 1 wide ⅜ thick

Fig 2

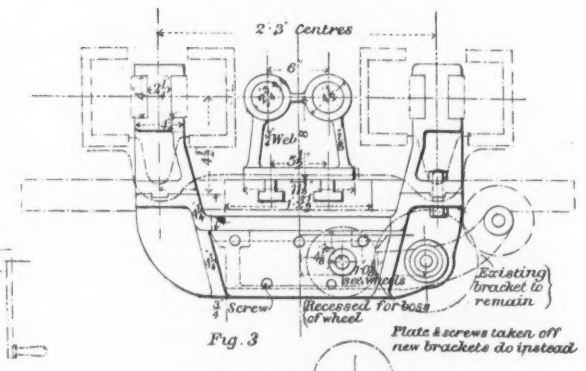
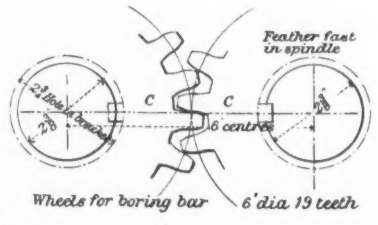
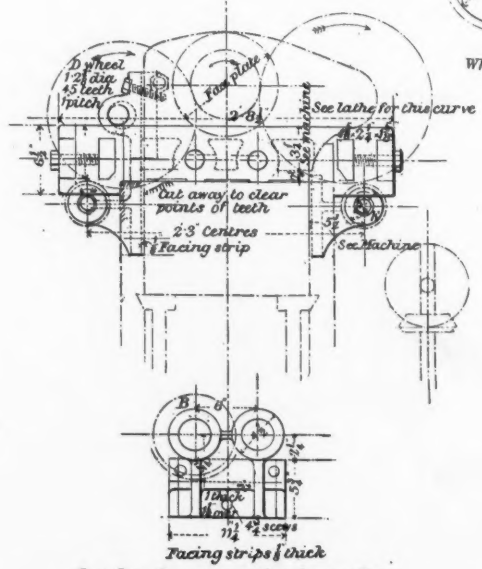


Fig. 3




D wheel 1·2½ dia. 45 teeth 1 pitch
Fast plate
See lathe for this curve
Cut away to clear points of teeth
2·3 Centres
Facing strip
See Machine
Facing strips ¼ thick
Bracket for supporting boring bars.

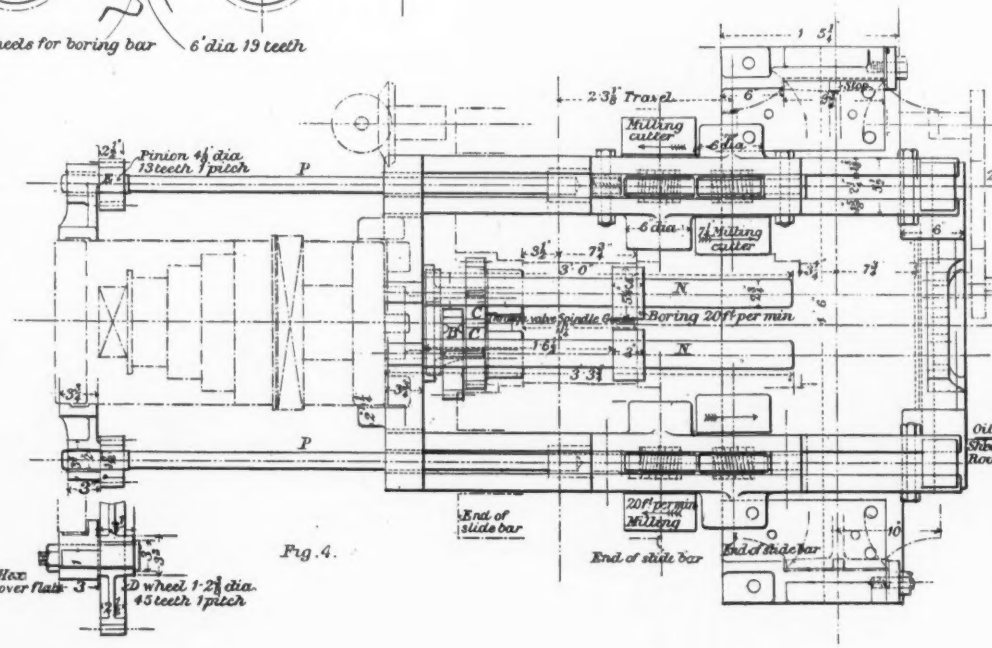

Pinion 4½ dia. 13 teeth 1 pitch
2·3⅜ Travel
Milling cutter
6 dia.
7 Milling cutter
Boring 20 ft per min
Oil bath
Sheet iron Rough at end
End of slide bar
20 ft per min Milling
End of slide bar
Hex ½ over flats
D wheel 1·2½ dia. 45 teeth 1 pitch

Fig. 4.

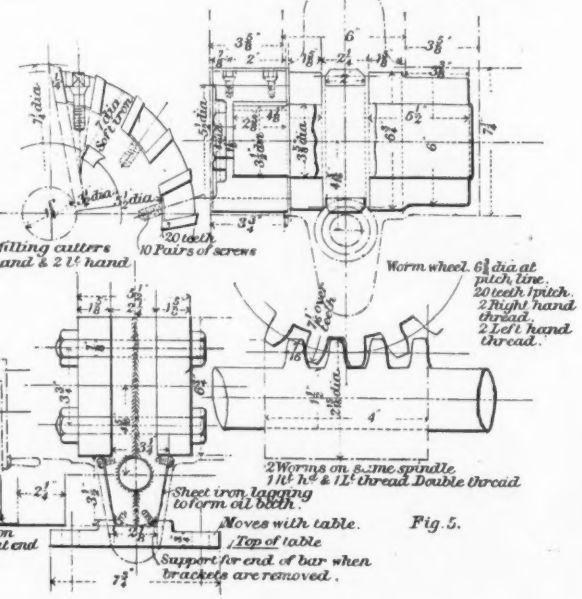
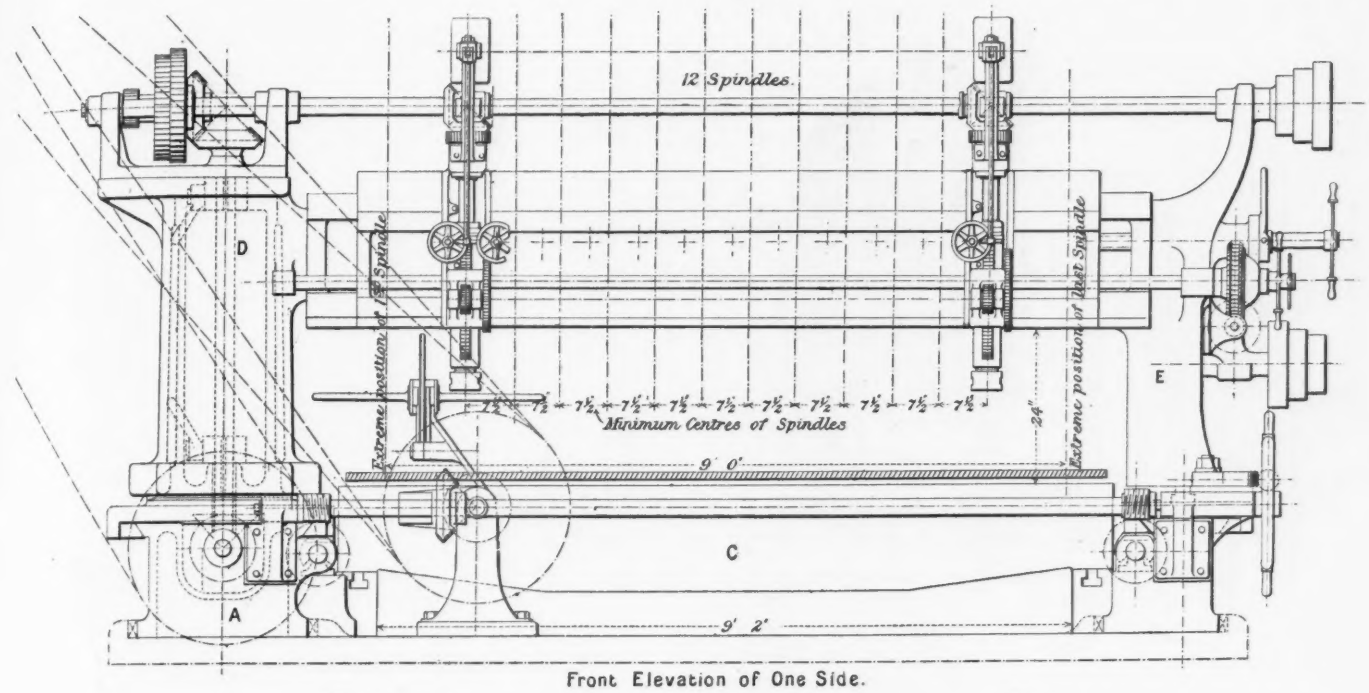
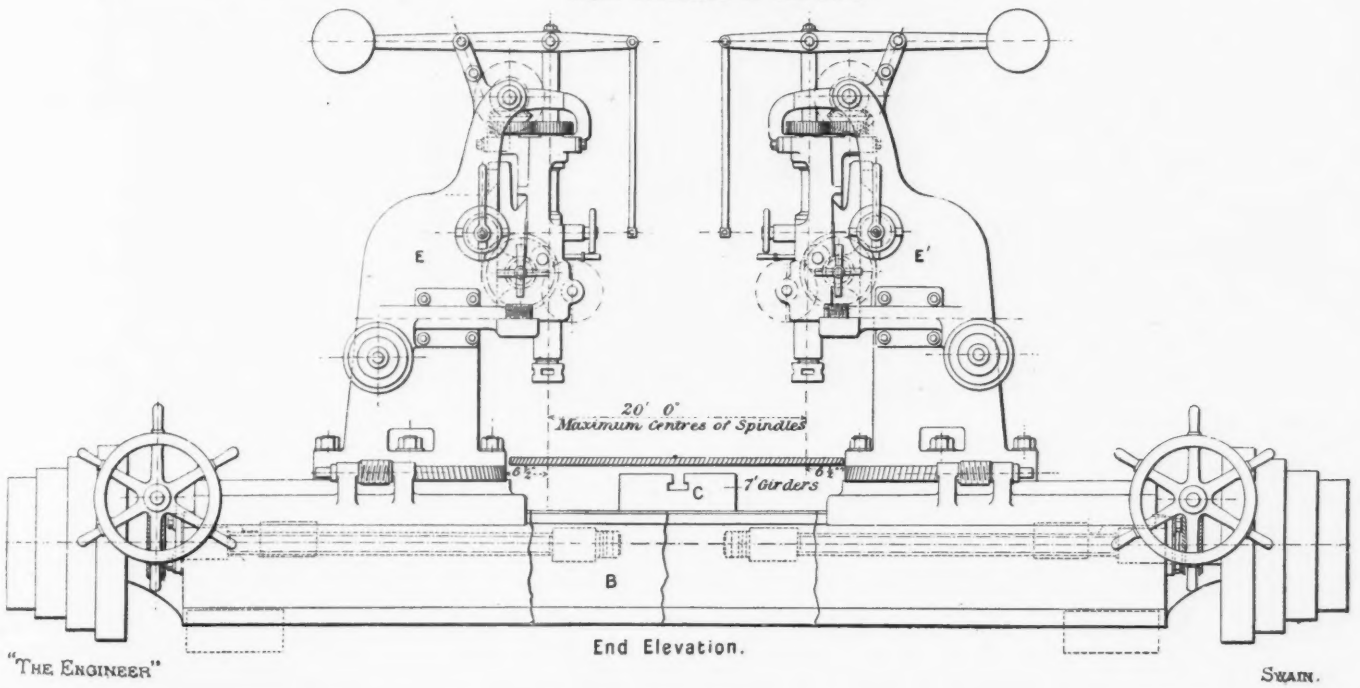

4 Milling cutters 2 Rt hand & 2 Lt hand
20 teeth
10 Pairs of screws
Worm wheel. 6½ dia at pitch line. 20 teeth 1 pitch 2 Right hand thread. 2 Left hand thread.
2 Worms on same spindle 1 Rt hd & 1 Lt thread Double thread
Sheet iron tapping to form oil bath.
Moves with table.
Top of table
Support for end of bar when brackets are removed.

Fig. 5.

DOUBLE MULTIPLE PLATE DRILLING MACHINE



Front Elevation of One Side.



End Elevation.

"THE ENGINEER" SWAIN.

the frame has in consequence to be like Fig. 27. The manner of machining the curved face A is as follows:—In the first place, the flat face B of a number of frames is planed. A planing machine was available in the shop; it has four heads, two on the cross beam and one on each standard. Only one of the latter is used for planing the frames. On the table are mounted some six heavy cast iron angle plates, which stand up like a wall; on to these are bolted a string of frames, their curved faces outwards. The cross slide is raised a good way up, and helps to support a stiff plate which extends at the side of the machine down to the ground. It carries a channel correctly shaped to the proper curve. In the channel is a roller on an extension of the tool box slide. This channel, as the feed is put on and the box rises or falls on the column, moves the tool in and out as required. The frames are taken straight from the machine and fixed to the boiler without further fitting.

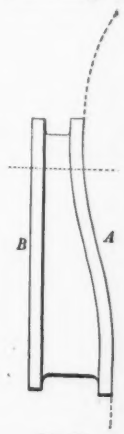


Fig. 27

There is being constructed for the Nine Elms works by Sir W. G. Armstrong, Whitworth and Co., Limited, a very noteworthy double multiple plate drilling machine, designed by Mr. Drummond, through whose courtesy we are able to reproduce the general arrangement. The machine will deal with plates up to 10ft. by 20ft., drilling holes in them anywhere within 6in. of each edge. The machine consists of two long girders coupled together by several cross girders C, which support the plate to be drilled. Upon the girder A stand two pillars, D and D¹ behind, and upon girder B stand two columns E and E¹. Between D D¹ and E E¹ are cross slides, each of which carries twelve drill spindles. The minimum distance apart of these spindles is 7½in., so that in use all the alternate holes in a line are drilled at once. Both cross slides can be moved up and down the main girders, so that every part of the plate can be got at without further setting. Furthermore, to provide for the drilling of sloping lines of holes, as in the case of rivet holes for the foundation rings of fireboxes, each of the pillars E and E¹ is provided with a worm ring at its base, so that it may be revolved whilst each of the other columns is left free to revolve in the manner shown. Thus, by traversing either D or E along the girder, whilst the other remains fixed, the cross slide can be set at an angle across the plate. The maximum movement is about 12in. at each end.

On other points the drawings are practically self-explanatory. It will be observed that there is special power gearing, with separate drive for moving the cross slide along the girders, and that the drill heads are all mounted on a slide capable of movement as a whole along the cross slide, so that once the pitch of the drills has been set, they can be moved bodily backwards and forwards across the plate. The drilling spindles are being constructed to meet the constant difficulty with multiple drills, that all the drills are not the same length. The drills to be used in this machine will be grooved the whole length, and will be driven by a feather in this groove. Each drill spindle is to be fitted with a collet chuck. The drills will be put in regardless of length, and the heads lowered till all the drills rest on the plate, then the collets will be tightened.

GREAT EASTERN WORKS, STRATFORD.

Considerable energy and acuteness are being displayed at the Great Eastern Railway Company's works at Stratford to make omelettes successfully with as few eggs as possible. It is no secret that the company is not rich, and has not the means for providing its works with much of the most recent machinery, or for reorganising them on a large scale. We are enabled, by the courtesy of Mr. Holden, to show, however, what economies can be effected by able and careful management. The Stratford works date back many years, and there have been not a few prejudices and customs to overcome in introducing methods which are looked upon as hopeless, and speeds which are regarded as reckless. Still, it has been done; and the only conclusion we can arrive at from the figures which we are about to discuss is that the more steps that are taken in the same direction the greater is likely to be the satisfaction.

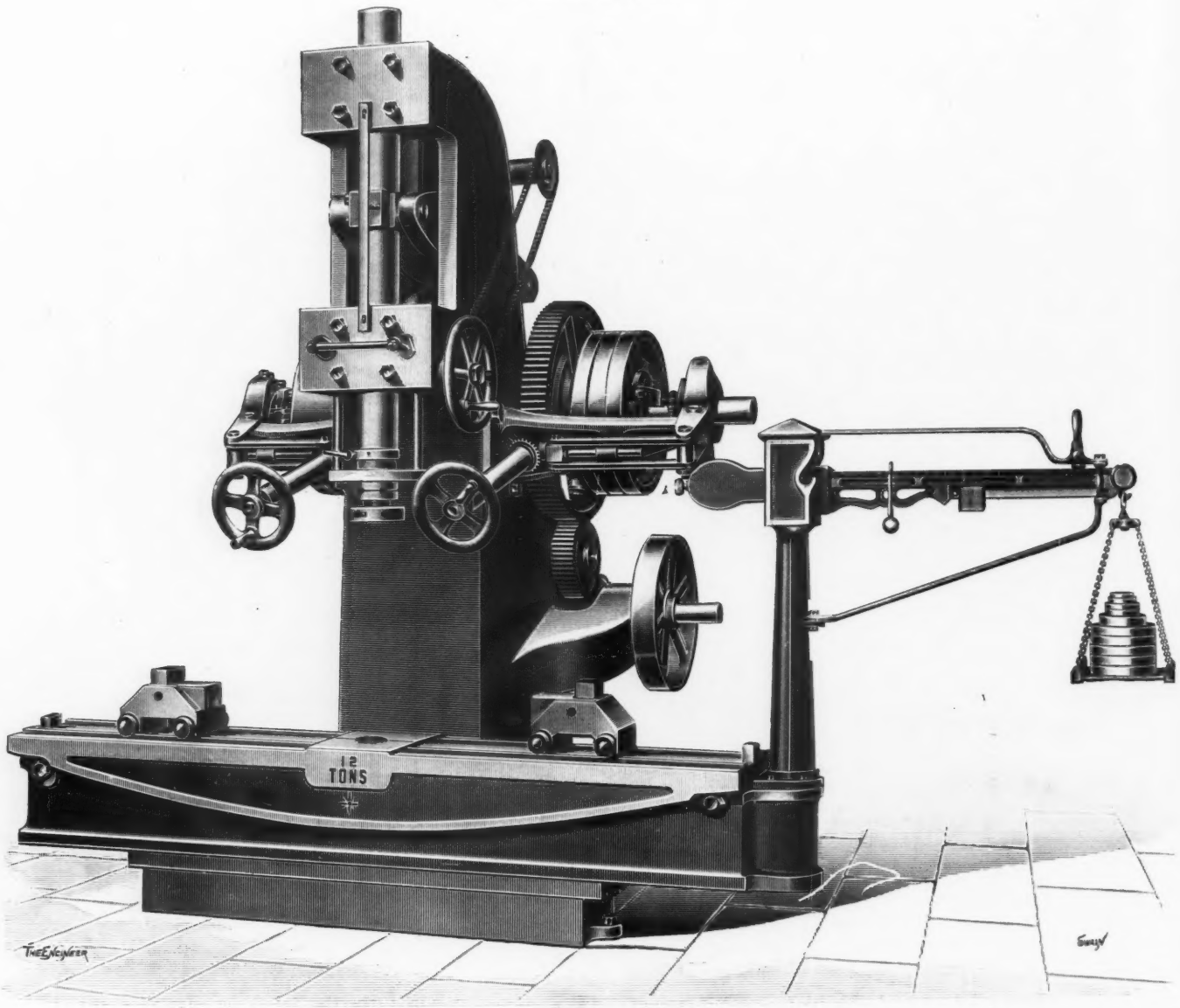
Let us look first at the automatic machines. Four of these are in use, all by Alfred Herbert, Limited, of Coventry. They are employed on general stud or pin work, which was originally done on forged material. The saving effected by their use is greater than might have been anticipated. The four machines are at present under the charge of one man, but up till recently he had only three to look after. At that time ¼in. studs were being turned out at a saving of 44 per cent. over the old method, 1in. studs at 40 per cent., and ⅝in. pins at a saving of 59 per cent. Thus during the year 1900 there was a total saving of £360 on these three machines. The same man has subsequently taken under his charge a fourth machine making roof stay bolts—short square-headed screws which bolt the crown to the bridge stays.

On the basis of one man to four machines the saving effected by doing this job automatically is 30 per cent., the prices being so adjusted that the workman is able to make a slightly larger balance with four than with three machines. Taken altogether, including capital charges and supervision—a large item—these four machines are worth £520 saved per annum, which, even when a certain amount is written off for depreciation, is a sufficiently startling result. It may be remarked, further,

TAFF VALE RAILWAY—SPRING TESTING MACHINE

JOSHUA BUCKTON AND CO, LIMITED, LEEDS, ENGINEERS

(*For description see page* xv.)



that occasional jobs which had before to be done on screw-cutting lathes are now performed on these automatic machines at something like one-tenth the total cost. Of course, as we have frequently pointed out, the value of automatic tools depends on their being constantly in use, an idle week with such expensive machines being

Fig. 28—VALVE BODY CHUCK

sufficient to considerably reduce the actual percentage of saving, though it does not necessarily affect the rate of saving. The loss, that is to say, is simply that due to unemployed capital.

To take another interesting case of the economy effected by the use of a modern tool. In the brass finishing shop, a capstan lathe, also by Herberts, has reduced the time of finishing a 1in. Westinghouse cock from two hours to 30 minutes; of injector steam pipe nuts from 36 minutes to 20 minutes; of injector steam pipe stuffing-boxes from two hours to 50 minutes. Sketches of the first and last are given in Fig. 29. In the former the two ends are bored and screwed, and the plug hole bored and screwed; the second is machined all over. Such a reduction of time, it will be admitted, is the more remarkable when it is borne in mind that the material is hard and durable, and that expensive forming tools have to be used for part of the work. The saving on the first of these items is due largely to the use of a universal chuck which Herberts made for the purpose. It is illustrated by Fig. 28. The work, it will be seen, can be turned over, so that both ends can be turned and screwed at one setting. The chuck illustrated is not exactly the same as that employed at Stratford, being of a larger size, but it is essentially similar in design. The valve body to be machined is gripped between two jaws of suitable form, fitted into slotted discs, one of which is seen. In many chucks of the revolving type difficulties have arisen, because in order to revolve the work it was necessary to slightly slacken the grip, and thus a chance of the work slipping more or less arose. In the Herbert chuck, in order to avoid this possibility, ball bearings have been fitted to the revolving jaws, and the jaws have been coupled together by gearing concealed in the body of the chuck. The ball bearings reduce the friction of the jaws to such an extent that they can be readily revolved by putting the chuck spanner on the square shaft provided for that purpose, and as the two jaws revolved together there is no possibility of slipping. Dividing notches are cut in the edge of one of the slotted discs, the locating pin for which is shown in the engraving. A screw is provided for locking extra securely when dealing with heavy work.

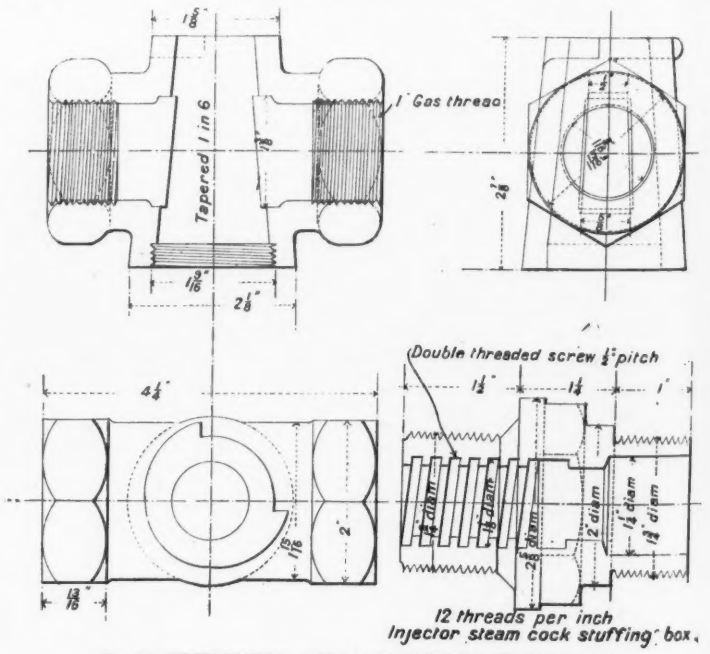
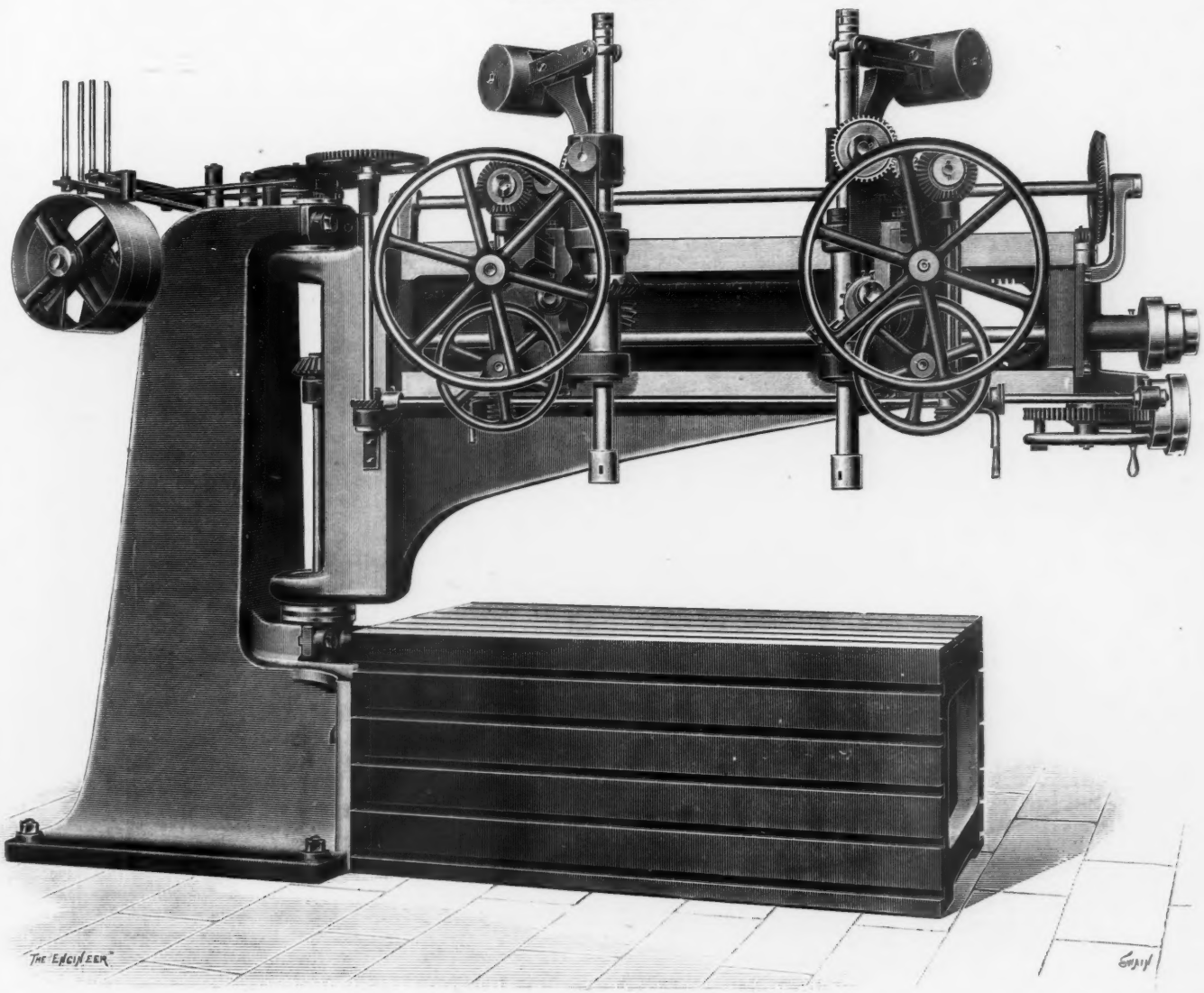


Fig. 29—WESTINGHOUSE COCK AND INJECTOR STUFFING BOX

TWO-SPINDLE RADIAL DRILLING MACHINE

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS

(*For description see page* xv.)



Small nuts and unions are now turned out from bright drawn brass and brazing metal at little more than half what they cost when made from castings.

An interesting example of the use of a small boring mill is afforded by the case of two machines made by George Richards and Co. They are both attended to by one man, and are largely employed, one on cutting piston rings from a deep cast iron cylinder, the other in facing slide valves, crosshead covers, and similar work. Piston rings were originally made on an ordinary lathe, the turning, boring, and parting off costing about 4d. per ring. The vertical lathe now turns them out at 1½d. each, a saving of 63 per cent. This is partly due to the fact that one man looks after two machines, partly to the convenient arrangement of the tools required in a revolving head, and partly to the greater rapidity with which the work can be chucked. The slide valves and crosshead covers used to be done on a planing machine, usually, in spite of drawbacks, accounted a cheap tool, but the effect of facing them on a vertical lathe has been to reduce the cost in the one case from 9d. to 5d., and in the other from 10d. to 3½d., or a saving of nearly 45 and 65 per cent. respectively. It is well to remark, that whilst these economies are being effected by the machines in favour of the company, the workmen are profiting by it also, as the prices are arranged in such a way that for each additional machine a man takes on he is able to make a little more money per week.

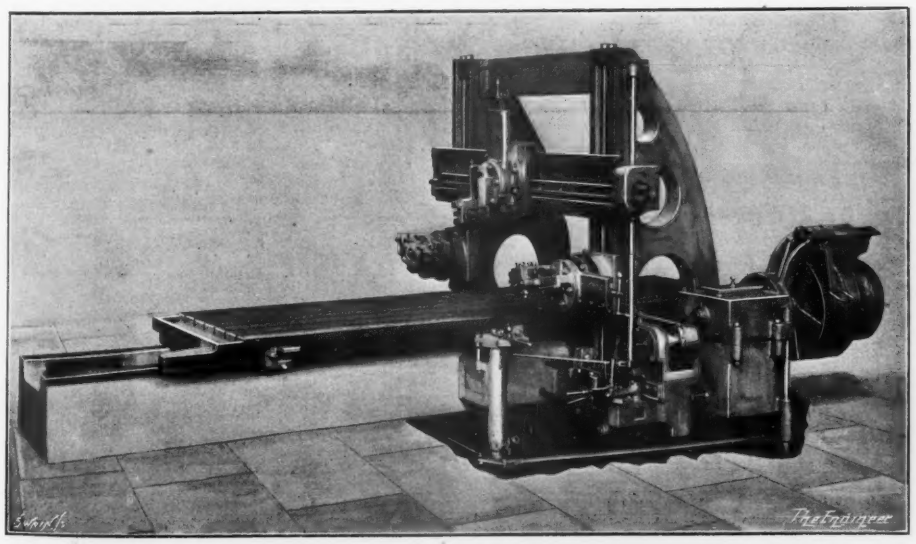


Fig. 30—PLANING MACHINE WITH SELLERS' DRIVE

We turn now for the moment to the question of forging, as, if properly conducted, it may have a very remarkable effect on the cost of machining. Let us consider the case of side rods. On the Great Eastern engines these are of the I section. Some years ago an attempt was made to roughly forge them to this section, and so reduce the cost of milling the channels out from the solid, a plan still followed at Swindon. Recently, however, the problem has been attacked again with complete success. A rough outline of the method of forging will not be out of place. Mild steel is used. It is reduced from the bloom to a bar, on each end of which the enlargement for the pin and oil-box is stamped between dies, and a hole punched through. The bar is then, from centre to centre, several inches shorter than the finished length. A pair of dies of the form shown in the annexed sketch is then fitted in the hammer, and the bar, being re-heated, is worked between the two dies until the channel is formed in it on each side and it is swaged out to the desired length. From five to six heats are generally sufficient to make a rod. The difficulty of old appears to have been in keeping the channels perfectly central; this has been entirely got over by the form of dies indicated. As another point in the manufacture of these side rods which affects machining more or less directly, it may be mentioned that the dies for the ends, formerly very expensive articles of steel, are now made of cast iron without any hand work beyond fettling. The cast iron blocks are surrounded by stout steel rings driven on hydraulically. Blocks made in this way are good for four or five dozen ends, but when they are finally rejected and the steel hoops removed they not infrequently fall into forty or fifty pieces. Attention may be also directed to the fact that the pin holes are punched, because it is in many works the custom to trepan them from the solid. The same observation applies to the big ends of connecting-rods. It is the practice at Stratford to punch the holes out under the hammer; the diameter is about 6in. and the thickness nearly as much—a fine bit of punching; needless to say it is done hot. The effect of forging the side rods in this manner has been to effect a total saving of about £3 10s. per set of two rods over the old method of milling the flutes out of the solid. The amount that has to be removed now by the mill is very small, the forging to size being surprisingly accurate.

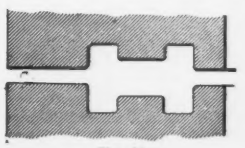


Fig. 31

Drop-stamping is making its way in all quarters, and not less in locomotive works than elsewhere. At Horwich a set of drops has been in use for many years, at Swindon

a large plant exists, and at Stratford a set of three Brett's stamps have been recently put down and are yielding very satisfactory results. Not only do they greatly reduce the amount of work requiring to be done on the forgings, but in some cases they obviate it entirely. Thus, for example, spring hanger nuts are drop-stamped with such accuracy that, except for tapping, no machining is necessary. With carriage coupling nuts it is the same thing. Formerly the two trunnions for the link were turned, now they are left black, and the only work done on the nuts before they go into position is driving a tap through the hole in the centre. The cost has been thereby reduced no less than 40 per cent. in the latter and over 64 per cent. in the former case. Carriage pipe eyes are now stamped at a cost of 10s. 9d. per dozen, instead of 24s. 9d. as formerly. They require, besides, drilling and screwing. Sketches—Fig. 32—of these various parts, with dimensions, will emphasise the value of the works.

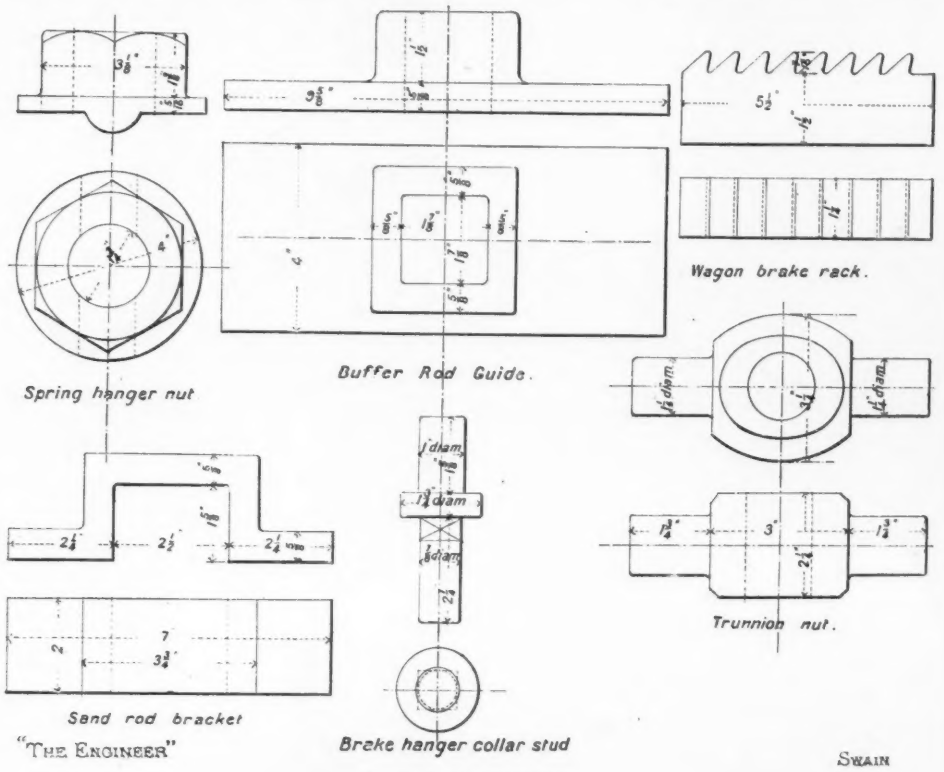


Fig. 32—DROP STAMPINGS

To a certain extent improvement in moulding has had a similar effect to greater refinement in forging. A Tabor machine is used in the Stratford brass foundry. A method of making the pattern plates which is far cheaper than the old plan of casting the group of patterns in gun-metal, and then getting them up by hand and mounting them on an iron plate, has been found. A special white metal mixture, composed as given below, takes the place of the gun-metal. The patterns are made in wood in the ordinary way, allowance for double contraction being unnecessary, and the plate is cast with the patterns in one piece. It is sufficient to rub up with emery cloth to produce a surface quite satisfactory for moulding such shallow articles as are suitable for this class of work. The composition of the mixture is tin 79 per cent.; antimony, 12·5 per cent.; and copper, 8·5 per cent. This alloy only contracts $\frac{3}{64}$in. in 24in. It gives remarkably good results.

For a good many jobs milling has replaced slotting and shaping, and the result, generally speaking, has been a saving of something like 50 per cent. The adoption of two or even three speeds on planing machines has also had excellent results. It has been found possible to very largely increase the rate of cut without injurious effects on either the work or tools. This has not been done without opposition, as several of the machines speeded up have been at work for many years, and prejudices as to their capacity were not immediately overcome. There appears to be a general tendency all round to increase the speed of planing machines, and with this object in view Sellers' gear is being largely adopted by several makers, as it gives a far sweeter and steadier drive than a rack, and is less wasteful than a screw at high speed. It will not be out of place here to refer to a fine example of planing machine with Sellers' drive made by Joshua Buckton and Co., Limited. It is illustrated by Fig. 30, and is of the same type as a machine supplied to the Great Eastern Railway.

It has three tool-boxes. One tool box is on the cross slide, and one on each of the uprights. The machine is driven throughout by spiral gearing, which is so far noiseless and free from vibration that a broad finishing cut may be taken without leaving chatter marks upon the work. There are several special advantages in this machine which are not generally known. The feeds are given to the tool boxes by independent belt power, and the knockers on the table are not called upon to work ratchet levers to effect the feeds, but only to make a connection with the continuous revolving pulley, which is automatically thrown out when a complete revolution has been made. By this arrangement it is as easy to take a broad feed of $\frac{1}{4}$in. for finishing the work as to take a fine feed of $\frac{1}{16}$in. for roughing it, and these feeds are taken, not by means of extending the time for acting upon the feed gear, which involves a drag upon the tool, or the necessity of extra gear to lift the tool clear of the work, but the whole of these feeds are taken at the moment of reversal, so that if the tool has 1in. clearance beyond the part that it is cutting, the feed is completed while the tool is clear of the work before it re-enters it. The speed of the feed motion is such that the whole of the feed is effected in one second, whether it be $\frac{1}{16}$in. or $\frac{1}{4}$in. feed. Another great facility in this machine is that by tripping the automatic gear which throws out the connection with the revolving pulley, the feeding action may be prolonged for the purpose of adjusting the tool-boxes either across the cross slide or up and down the arms, or for raising and lowering the cross slide itself. By this means the tool boxes are very rapidly adjusted with.

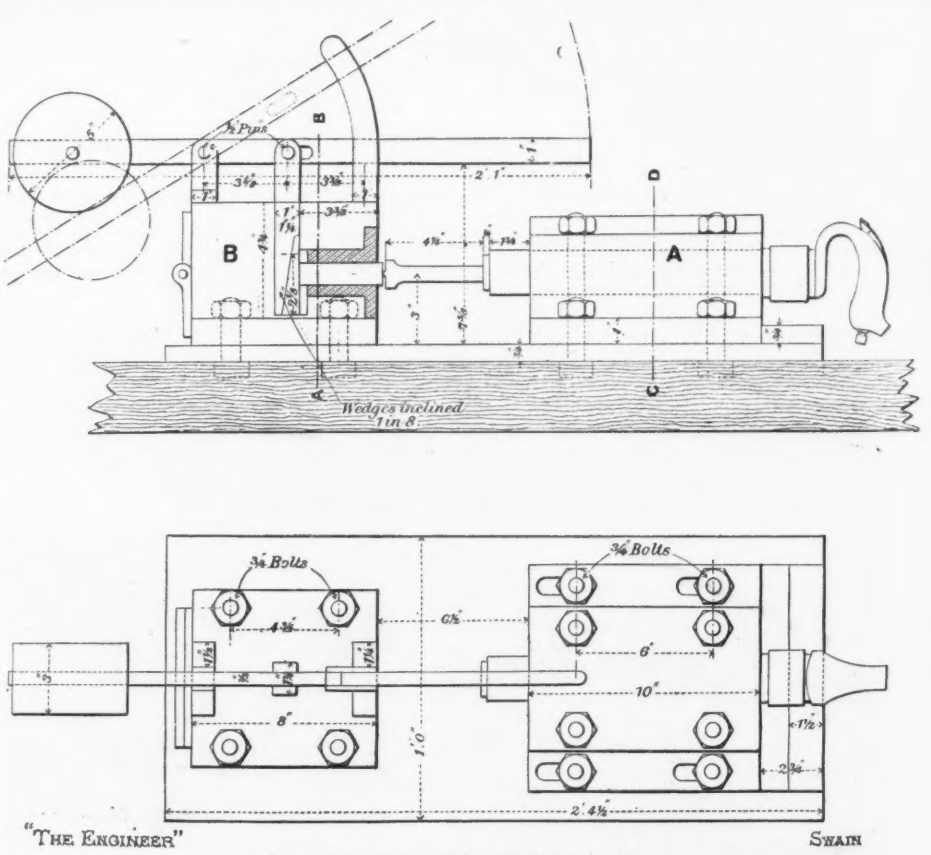


Fig. 33—PNEUMATIC STAY CENTERING TOOL

out the use of a handle, and this is found to save both time and labour to the operator, and to expedite the work very materially indeed. Another advantage in this machine which is not as yet largely known is that it can be arranged to cut on both strokes. The feed motion described operates at each reversal of the table; thus, if a $\frac{1}{4}$in. finishing traverse were being used, the tools would have covered 1in. width of surface with one double stroke of the machine.

Joshua Buckton and Co. have been for some years developing the system of double cutting, and the details of their tool box have now been so perfected that there are no difficulties in the setting of the tool. Fig. 34 shows one of their latest double cutting tool boxes to an enlarged scale. It will be seen that the tools are well held, and all the set screws for holding them are readily accessible. Each tool is carried in an independent swivelling tool holder. There is no back pressure upon it which injures its edge. The tools are set back to back and are exactly in line with each other, thus the front tool cuts away the material and makes a clear path for the trailing tool to follow in. When the machine reverses and the feed is given to the box, what was the trailing tool becomes the cutting tool, and what was the cutting tool trails in a path that is cut clear for it by its companion tool. If the work be of a nature where there is no room for the over-run of 6in. between the tools, such as the inside of a steam chest, then one of the tools is removed, and the other one, which may be either the forward cutting or the backward cutting

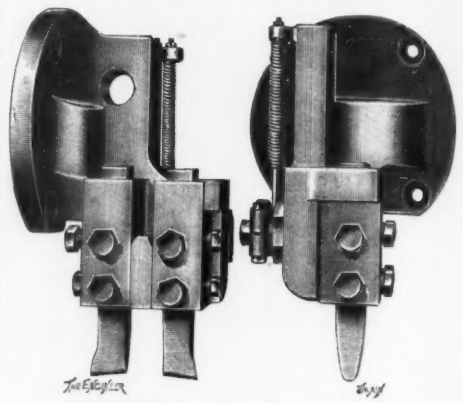


Fig. 34—DOUBLE TOOL BOX

tool, whichever is convenient, is alone used, and it is as well held in this tool box as any single tool can be held in the ordinary flapper tool box of a planing machine. One of the impediments to the larger use of double cutting tool boxes has hitherto been that when doing inside work a long projecting tool was not so well held as in an ordinary flapper tool-holder, but the new box gives such good support to the tool in every direction that this difficulty appears to have been surmounted, and the advantage of cutting both ways when the work permits it is not discounted by any want of facility for holding the projecting tool for inside work. These tool-holders, we are informed, can be applied to any planing machine of adequate capacity, and to almost any type, and by their addition the output is very nearly doubled. If an existing machine has a quick return motion, a tool of quick-cutting steel may be used, and the cut can be taken without any alteration to the drive. These tool boxes are not in use, we believe, on the machine at Stratford.

In all machinery, and in all the shops we have recently visited, the necessity of greater accuracy in sharpening the tools used is appreciated. Everywhere the workmen are entirely prohibited from using the grindstone themselves, or matters are in a greater or less state of progress towards this desirable end. A staff is solely employed on the preparation and upkeep of tools of all descriptions, and one man is set apart to use a special

grinding machine for supplying the machine hands with freshly sharpened tools as required. Sellers' tool grinder appears to be the favourite, as it is found that the lateral motion of the stone itself, combined with the proper motion and inclination of the tool, give better and quicker results than in other makes. The arrangements for setting the angles are very complete. A machine of this description is in use at Stratford.

The use of pneumatic hand tools is, of course, making its way in all works, and the following interesting comparison has been given to us by Mr. J. Holden. The tools used are Boyer and Little Giant.

The relative times for different classes of work are :—Drilling by hand, 10 min.; by Stowe shaft, 3 min.; by pneumatic, 22 sec. Tapping by hand, 6 min.; by Stowe shaft, 1 min. 46 sec.; by pneumatic, 36 sec. Caulking, one pneumatic does the work of three men. Pneumatic tube expanding is on its trial at Stratford, and promises favourably.

The methods adopted at different works for manufacturing boiler stays afford an interesting study. The Great Eastern method appears to be as good as any. The stays are made from rolled bars of Stone's bronze. They are cut off to length by circular saw, and are straightened and centred in a little machine with three rollers, one of which can be swung out excentrically to allow the stay to be put in. Fixed drills at the same time make the centres. The stays then pass to another small machine made at the works, which rapidly puts a chisel cut in one end to fit the driver on the screwing lathe. As this is the quickest method we have seen in operation for centering, a sketch of the apparatus may be welcome. Fig. 33 shows it. It consists simply of a pneumatic hammer, held firmly in a cramp A. This hammer carries a suitable tool. Opposite A is a wrought iron vice B, consisting of two parts hinged together. The upper and lower jaws of the vice carry a kind of half metal gland each, between which the stay is gripped when the lever shown is pressed down by the operator. Behind the work is a pair of wedges operated by the same lever, and serving to press it up against the tool. With this simple tool the stays are made ready for the lathe with great rapidity by a boy. From it they go to the saw, which puts four longitudinal slots in them, and thence to the screwing machines, semi-automatic tools made by Craven Brothers. These have a cam for throwing the lead nut out and disengaging the tool at the end of the stroke, the carriage at the same time returning automatically for the next cut. They are run at 500 revolutions per minute, and at most not more than three cuts are necessary to produce an excellent thread. The whole time occupied in producing a stay from a cut-off length can scarcely exceed one and a-half to one and three-quarter minutes.

SOME LOCOMOTIVE SHOP TOOLS.

As conclusion to this Supplement we propose to describe a few special locomotive shop machines. It would have been possible to devote profitably a great deal more space to such descriptions, and our reasons for not doing so at the present time have been already given. On another occasion we shall, possibly, speak of the work of the many other makers in this country who have turned their attention to this subject.

The engraving on p. xii. shows a spring testing machine, made by Joshua Buckton and Co., of Leeds, which will not only weigh and measure the deflection of the spring, but will give it a rapid action such as it would encounter in running on a permanent way, and will then exactly weigh and measure the falling off in the spring if there should be any. It is designed to test laminated springs, helical springs, and volute springs up to 12 tons pressure, up to 7ft. 6in. long and 1ft. 4in. high. The maximum stroke is 15in., variable down to 3in., and the ram can be driven either at ten strokes a minute for accurately calibrating the resilience of the springs, or at 150 strokes per minute for testing the power of the spring to withstand rapid vibrations. The end of the ram is fitted with a screw adjustment to suit varying heights of springs. The pressure from the ram is arranged to act upon the springs through the same pin holes, which the weight of the rolling stock bears upon in actual running, so that buckles, eyelets, and other attachments are tested at the same time as the spring itself. When the machine is testing the springs with its rapid action the springs are made to vibrate through a range of 3in. or 4in. without the removal of the load, so that the spring and all its attachments are acted upon with the same violence as they would encounter if running at sixty miles an hour over 30ft. rails with imperfect joints. This machine is in use at the works of the Taff Vale Railway, Cardiff.

A radial drilling machine for boiler work is shown on page xiii. The special advantage of this machine is that it will drill two holes at a time at any distance from each other between 7in. and 5ft. The headstocks carrying the drill spindles have a motion of 14in. at right angles to the main jib of the machine—an exceptional arrangement which may be readily overlooked in the engraving. This enables lines of parallel holes to be drilled without swinging the main jib. The spindles are reversible for tapping, and all the handles controlling the machine are near the end of the jib. For drilling locomotive fire-boxes a special swivelling table is used in conjunction with this machine. There is a pit at the back of the main table, in which the table illustrated by Fig. 35 stands, and can be swivelled until it is in a vertical plane like the face plate of a lathe, as shown in dotted lines, or in a horizontal plane. The table itself has a circular motion, controlled by a worm and worm wheel, so that all four sides of a locomotive fire-box can be drilled at one setting of the table. Holes, in fact, at any angle whatever can be drilled in the work while the spindles of the machine remain vertical.

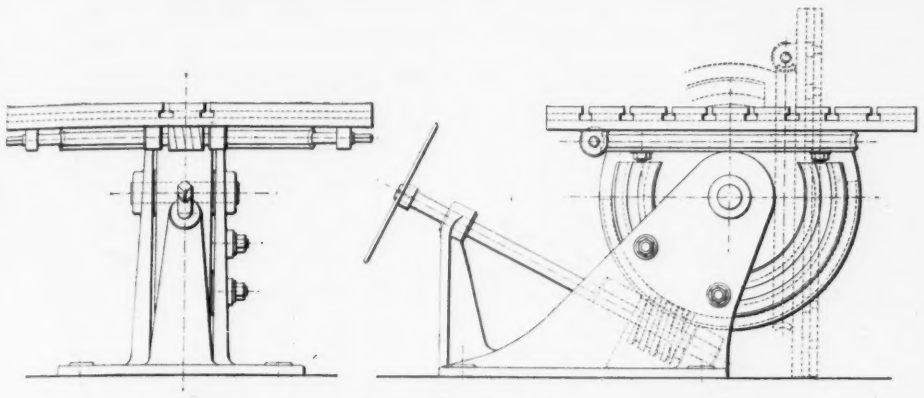


Fig. 35—SWIVELLING TABLE

Several machines constructed by Craven Brothers have already been mentioned in these columns. But several others remain to be described. It has only been possible to select from the large variety of machines made by this firm for locomotive works, a comparatively small number for illustration. Those taken may, however, be regarded as fairly typical. On page viii. three machines are illustrated. Two views of an electrically-driven milling machine for the New South Wales Government Railways are given. It is designed to mill the edges of a pile of boiler plates 18ft. long, 5ft. 3in. wide, or to mill the inside and outside edges of fire-box foundation rings. The main head has two carriages, each with a vertical spindle 4¼in. diameter, carrying a milling cutter 5in. diameter and 10in. long. The two carriages have self-acting motion on the cross slide, which, it will be observed, is made long enough to allow of one carriage being placed outside the width, and thus to allow a single carriage to mill across the ends of a pile of plates 5ft. 3in. wide. The carriages are adjustable on the cross slide by hand, and the slide which carries the spindle bearing is adjustable vertically by a screw. The spindles are driven by an electric motor, placed on the back of cross slide, through powerful gearing with machine-cut teeth. The main head is traversed along the bed self-acting for milling on both edges of a pile of plates, the feeds being worked from one of the gearing shafts; either of the spindles can be stopped independently by a clutch on each carriage, and the main head can be traversed quickly along the bed in either direction by a reversing electric motor. The self-acting feed for traversing the head on the bed is worked by two screws, one on each side of the bed, and geared together by a shaft in the cross slide and two vertical shafts and mitre gear—see the back view. When the self-acting feed is at work the screws are fixed, and the nuts on both sides turn on the screws; but when traversing quickly—say, for adjustment—the two screws, coupled together at the end of the bed by a shaft and gearing are driven by the electric motor above mentioned, the nuts being locked on both sides of the main head. The screws are supported in the centre of their length by self-acting raising and lowering bearings. The main head can also be adjusted on the bed by hand to put on the cut, either on the end or side of plates by handles on the front side of the main head. The bed is 24ft. 3in. long by 7ft. 4in. wide, with T bolt slots lengthways to fix the plates and to convey the lubricant from the milling cutters to a tank on the main head at the back of the machine. The machine is provided with a rotary pump and pipes to play lubricant on the cutters when working.

A flange plate milling and oval hole-cutting machine, by Craven Bros, is shown on p. viii. It consists of a strong bed to carry the standard and table. The standard is of strong box section, firmly secured to the bed, and it is fitted with a steel spindle working through a long cast iron tube which runs in capped bearings with gun-metal steps, with self-acting vertical feed and hand adjustment to suit the work fixed on the table; the spindle is driven by a four-speed cone pulley through spur and bevel gearing, to run in single or treble gear. The lower end of spindle is prepared to receive a milling cutter for milling the flanges of plates, a tool arm for cutting oval holes, and a saw for sawing the rough edges off flange plates in the same manner as described in connection with Nine Elms Works.

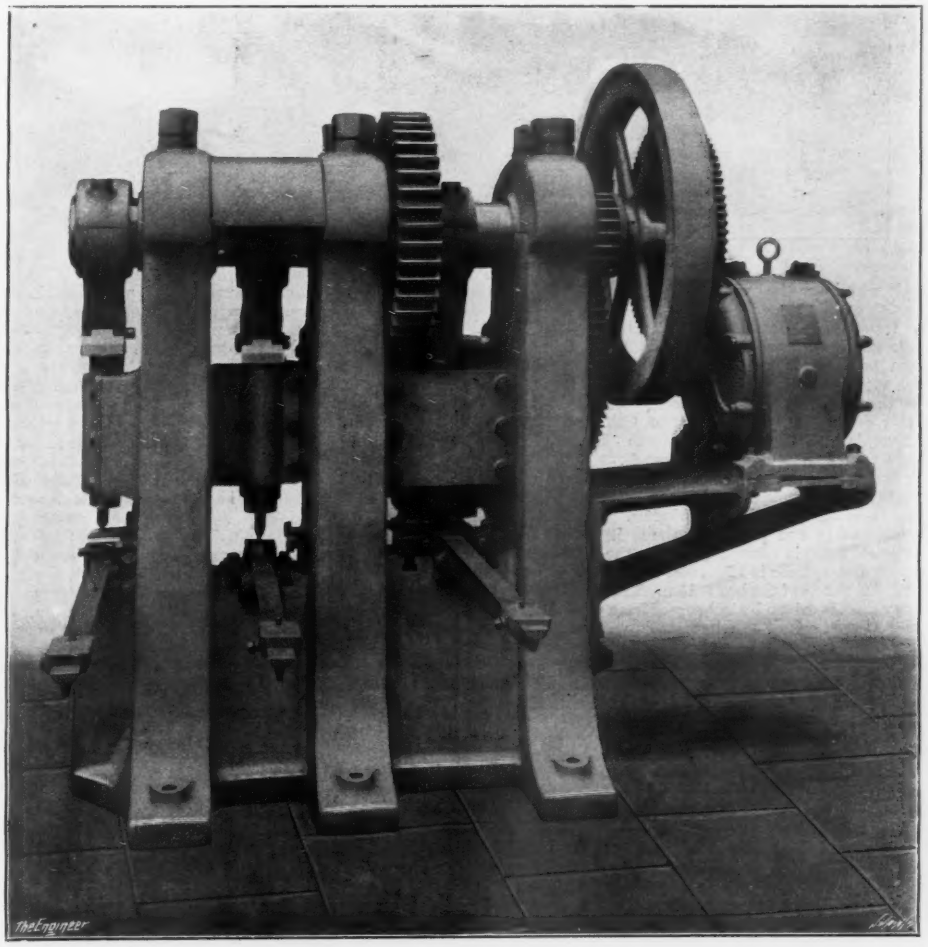
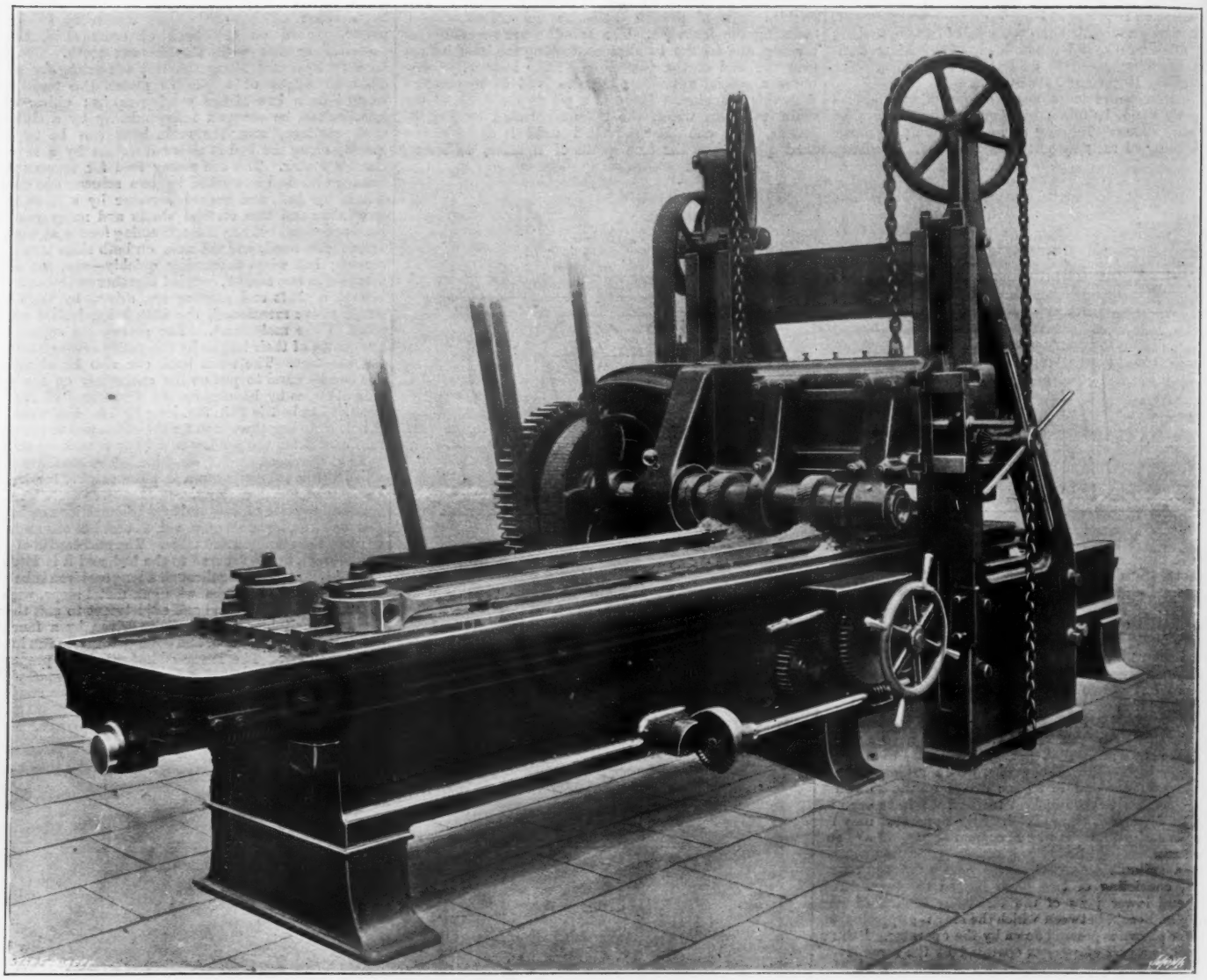


Fig. 36—SPRING PLATE CUTTING MACHINE

A circular table is mounted upon compound slides, with a dish round it to prevent the cuttings and lubricant falling on the lower slides. The bottom slide is adjustable longitudinally by hand, and has also variable longitudinal motion by a disc to traverse the slide longitudinally in relation to the vertical spindle when cutting out oval holes by the tool arm on the end of the spindle. The stroke of the slide and the adjustment of the tool on the tool arm can be varied to suit different sizes of ovals. This longitudinal motion can be disengaged by lowering the

HORIZONTAL MILLING MACHINE

SMITH AND COVENTRY, LIMITED, MANCHESTER, ENGINEERS

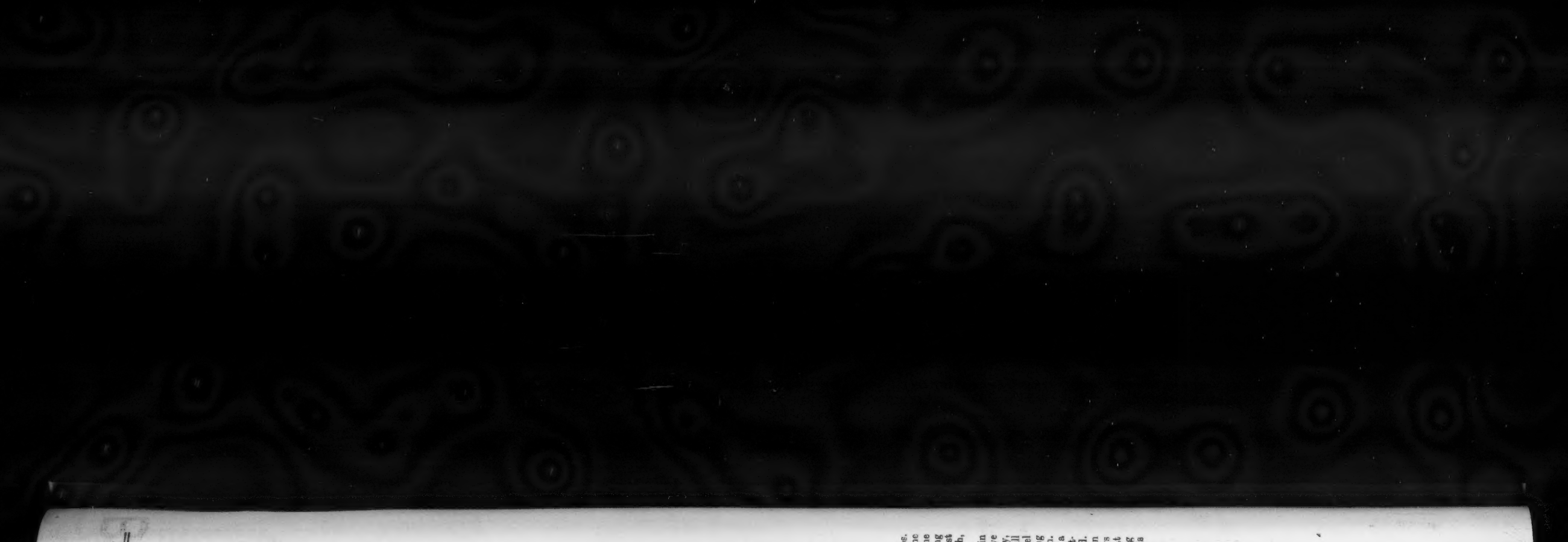


bevel wheel on the vertical shaft at the back of the machine out of gear when oval holes are not required. The transverse slide and circular table are adjustable by hand, and have self-acting motion in either direction, which is engaged by friction cones; power motion for quick adjustment driven by fast and loose pulleys direct from the line shaft is also provided. There are machines of this description at Derby, the Caledonian Railway Company's Works, Glasgow, North-Eastern Railway Works at Darlington, and at Horwich.

A double axle lathe, as illustrated on page viii,, adapted for turning both ends of tender, carriage, and wagon axles at the same time, is in use at Swindon. The driving headstock is cast in one piece with the bed. It is fitted with a hollow spindle in capped bearings; the diameter of hole through the spindle is 12in., and the height from centre of spindle to top of the bed is 15in. The spindle in the machine shown is driven by treble gear from an electric motor placed at the back of the headstock, with three changes of gear, and can also be run with three speeds of single gear for finishing. The right-hand following headstock or back centre is fitted with an internal spindle and inverted screw, with hand wheel adjustment and locking arrangement. The left-hand following headstock has a dead centre, and can be swivelled on one side to allow of axles being put in and taken out conveniently. The two carriages are fitted with compound slide rests, and thus four tools can be cutting at the same time. The variable self-acting motion for sliding is worked from the hollow spindle by gearing and back shaft to worm and worm wheel on the main screw at the front of the lathe, and clasp nuts on each carriage. Each carriage is fitted with quick hand adjustment.

A machine by Craven Brothers which departs widely from the majority we have described is illustrated on page xv., Fig. 36. It is used for spear pointing, slotting, and forming the nib on spring plate, and is worked in conjunction with a two-motion machine which first shears the plates to length from long bars and punches the centre hole. The machine shown is capable of dealing with plates 6in. wide by $\frac{1}{4}$in. thick cold, and up to $\frac{3}{4}$in. thick hot. The frame is of strong box section, with main excentric shaft of steel running in capped gun-metal bearings. The shaft drives three steel connecting-rods which work the three slides carrying the tools for spear pointing, nibbing, and slotting respectively. Each motion is provided with adjustable gauges and stops. In each motion the spring plate is carried on a peg by the centre hole, and turned round end-to-end to perform the operation at each end of plate, thus ensuring the spring plates being equal-ended, and duplicates after the first setting. Machines of this kind are in use at Horwich, Derby, Gateshead, Nine Elms, and elsewhere.

A good example of a type of milling machine used in locomotive works is afforded by the illustration above showing an excellent tool made by Smith and Coventry, Limited. It has a bed 15ft. long by 3ft. wide, and it will mill, we are informed, the larger ends of the two steel connecting-rods each 11$\frac{1}{4}$in. wide simultaneously removing $\frac{1}{4}$in. to $\frac{3}{4}$in. depth of metal from each with a feed of $\frac{3}{4}$in. per minute. The table is driven by a screw, and has a variable self-acting traverse in one direction with adjustable knock-off stop, and can be run back quickly by hand. The cross slide, of which the proportions are well shown by the engraving, is raised and lowered by screws through worms and worm wheels actuated by handles at either end. The saddle can, of course, be traversed along the slide by a screw for adjustment. The machine is shown at work on a pair of side rods.



AMERICAN LOCOMOTIVES IN ENGLAND.

By CHARLES ROUS-MARTEN.

ACCORDING to the time-honoured rule of debate, the opener of a discussion has the right of final reply. But he is also subject to the condition that his reply must be deferred until all who desire to participate in the discussion shall have had their say. That has been my position hitherto, as the writer of the article about American locomotives in England which appeared in THE ENGINEER of June 14th last, and which has raised so long extended a debate. I may have felt inclined to say with Juvenal,

"Semper ego auditor tantum, nunquamne reponam?"

especially when some of my protagonists, forgetful of the restrictions which courtesy imposed upon me, taunted me with my silence, and implied that it was an admission of defeat; but until invited by the President of the debate —the Editor—I had no alternative but to "byde my tyme." It has come.

The object and purport of my article of June 14th were set forth with especial care and preciseness. I made it perfectly clear that I did not champion or defend American locomotives or locomotive practice against British; that I did not champion or defend the American engines imported by the Midland Company against the British engine built at Derby and elsewhere in Britain for the same work; and that I did not directly or indirectly allege or imply the slightest unfairness in the comparative tests made by my friend Mr. S. W. Johnson and his subordinates. I stated my view explicitly in the following words:—"While, on the whole, no exception can be taken to the fairness of the methods adopted for trying on the Midland Railway those two different classes of its own engines, such a trial affords no test whatever of the relative merits of British and American locomotives or methods of locomotive practice." Surely that is sufficiently distinct? Again, I said of Mr. Johnson's engine which was tried against the American:—"Its design is not only practically efficient and handy, according to British practice, but it is also symmetrical and handsome in an exceptional degree, and worked—as British engines have to be worked—to the full extent of its capacity, it is probably as perfect a machine as could well be devised for its purpose within our present knowledge." And I added:—"Comparing engine with engine on the basis of efficiency per unit of nominal power—reckoning the capacity of the boiler and fire-box, as well as of cylinders and wheels—and also on the basis of performance per unit of nominal power, I am firmly convinced that no locomotive exists in the world that is superior to the British."

I am obliged to reproduce these utterances because they have been curiously, although, I feel sure, quite unintentionally misrepresented. So many people read without perceiving, or perhaps I might say "skim" without really "reading," that they often miss the true point, and so they attempt to answer, not what a writer actually says or implies, but what they fancy he has said or implied, or what they think he ought to have meant to say or imply. This often leads to mental confusion, as in the present case. One of my critics takes exception to my use of the epithet "superficial" as applied to these modes of thought, yet he himself affords a practical justification of its correctness by attributing to me certain views which I had expressly and emphatically disclaimed. I set forth my attitude in the following terms:—"I do not write in the smallest degree as a partisan. I have not the slightest interest in praising or defending one engine or one country's engines at the expense of another or others, nor have I the faintest inclination to do so." Yet "A Locomotive Engineer" refers to "Mr. Rous-Marten," whose article *in defence of the American locomotive* was published in THE ENGINEER on 14th inst." My article was not in "defence of the American locomotive," and was distinctly stated not to be. This is a specimen of the general attitude of those who have criticised my article. They say that I defended the American locomotive—I did not; that I disparaged the British engine by comparison—I did not; that I advocated American locomotive practice as against British—I did not.

I do not pretend to imagine that my personal opinions are of any value in this matter, unless as those of one who has had somewhat special opportunities of observing and comparing the working of British and American locomotives in various parts of the world, and who has largely used those opportunities. But I may perhaps be allowed to say, that so far from being an advocate or defender of American locomotive practice, I personally dislike almost every point in which American practice differs from British. For example, I dislike the American bar framing, outside cylinders, steel tubes, steel fire-boxes. I prefer the British plate frames, inside cylinders brass tubes, copper fire-boxes. I dislike the roughness of most American workmanship, and I cordially recognise and admire the perfection and fine finish of British workmanship. But all this is no news to those who have followed the modern literature of the locomotive. My views, *quantum valeant*, have been freely published abroad as well as at home, and, in America as much as in England, I have freely criticised the curious roughness of workmanship visible not only in the goods engines supplied to the Midland Railway, but also even in the locomotives shown last year in the Vincennes Annexe of the Paris Exhibition as the finest products of American manufacture. So nobody who does not read and think in the most "superficial" manner can possibly see in me the "champion" or "defender" of either American engines or American locomotive practice.

So far as I can remember, the sole feature in American locomotive practice which I have ever championed as against British practice is its larger dimensions. To avert misrepresentation, intentional or unintentional, let me say here as distinctly as possible that I refer solely to such dimensions as are feasible within the limits of the British loading gauge. I do not advocate running under 13ft. 6in. bridges American locomotives with chimney-tops 15ft. 6in. above the rail level. I advocate the adoption in Britain, as has been the case in America, of such enlarged dimensions as shall enable the rule of "one engine one train" to be carried out in all normal circumstances, and the excess of piloting, which so long was a discredit to our methods, satisfactorily abolished. Here again, of course, I do not refer to such abnormal cases of those of Shap, Beattock, Falahill, and Struan. But this point has now been virtually conceded by the chief mechanical engineers of all our principal lines. During the last four or five years they have increased their boiler-heating surface from a general level of 900—1200 square feet to 1500—2000 square feet, and the steam pressure from 140—160 lb. to 175—200 lb. This has been done on every one of the fifteen chief railways of Great Britain as it had been done long before in America. Therefore the only single point which I preferred in American locomotive practice to British is being adopted by our principal British engineers. So, even were I desirous to pose as the champion of American practice, the only ground on which I could take that stand is steadily disappearing in Britain.

It has been alleged, quite inaccurately, of course, that I "excused" the American engines for their inferior show in the Midland trials by saying that "their boilers are too small." I never said anything of the sort. What I said was that in America it was the practice to allow a larger margin of boiler power than these locomotives possessed—which is a totally different matter. Neither did I "seek to explain away the unfavourable position in which the published figures place the American engines." I simply contended that the trial "affords no test whatever of the relative merits of British and American locomotives or methods of locomotive practice." Those were my words, and that was the whole purport and subject of my article. "A Locomotive Engineer" refers to "the line of argument pursued by Mr. Rous-Marten in defence of the imported American engines." I "pursued" none, because, as I have made quite clear, I did not "defend the imported American engines." And the same writer says: "The trial of American and British locomotives on the Midland Railway gives the palm in favour of the British engines, notwithstanding all that Mr. Rous-Marten has, so far, advanced to the contrary." But I "advanced" nothing "to the contrary." So far from that, I stated in the most explicit language possible that "while on the whole no exception can be taken to the fairness of the methods adopted for trying on the Midland Railway those two different classes of its own engines, such a trial affords no test whatever of the relative merits of British and American locomotives, or methods of locomotive practice." And my critic actually quotes those words without apparently realising their purport. I really do not see how I could have stated more emphatically than I have that I do not prefer American locomotive practice, or that I do not question for a moment the superiority of the British engines which were tried against the American ones on the Midland Railway.

All this explanation is quite irrelevant to the issue I raised, but it is inevitable on my part, because it is necessary that I should sweep away certain pure irrelevancies with which it has been sought to obscure and confuse that issue, which is and was: That the Midland trials afforded no real test of the relative merits of American engines—I carefully used the general term, and did not say "the" or "those" American engines—or of American locomotive practice.

That is, and was, the sole point I raised, and the most copious verbiage in defence of British practice or in disparagement of American is absolutely *nihil ad rem*, because I never raised that "*res*" in my article. Therefore, if I am expected in my reply to "champion," or "defend," or "advocate," American practice against British, expectation will be most grievously disappointed. I never have done so, and I am not going to do so now. I repeat what I said in my former article, that in my opinion, "per unit of nominal power, and also on the basis of performance per unit of nominal power, no locomotive exists in the world that is superior to the British." Those were my words; are they not plain enough?

To assert that a specific trial of two sets of engines does not prove one country's locomotive practice superior to another's is most certainly not the same thing as to assert that one country's locomotive practice is superior to another's. That is a wholly different issue with which I have not yet dealt. To say that a certain prisoner did not have a fair trial is not to assert that he is innocent or guilty. In this instance I did not say that the Midland American engines did not have a fair trial, but I do say that if that trial be taken as the trial of American engines generally against British, or of American locomotive practice as against British locomotive practice, then that trial would not be a fair one. My sole reason for taking up the matter at all was that the non-technical Press generally was misled—and therefore was misleading the public—into the wrong impression that such a trial of engines, under those conditions, was a trial of American locomotive practice generally against British. That was, in fact, broadly stated in numerous journals, and it was believed by readers who knew no better. It did seem to me desirable, as I stated, "in the interests of truth, and fairness and science," that this error should be exposed and corrected. Therefore I did so. I cannot consent to have all sorts of strained and inaccurate constructions placed upon my plain words, and then to be called upon to reply to such misconceptions. With most of what is urged by my chief critic, who prefers to remain anonymous as "A Locomotive Engineer," I cordially agree. He terms my arguments "specious." Possibly they might have been had they been directed toward proving the issue which he sets up, but which I explicitly repudiated, the question whether the American or British Midland engines, tried comparatively, had proved the better. But as I simply took up the ground that there had been no adequate trial as between British and American engines generally, or between British and American methods of locomotive practice, my arguments were strictly to the point, and still remain unrefuted.

But there are two or three matters of interest which, although they are not germane to the true issue raised by me, may seem to casual readers to touch certain arguments that I used. My contention was that there was no real test of American *versus* British locomotive practice, because American engineers would not design or use for that class of work engines such as were tried; therefore that American engines and practice would necessarily be at an unfair disadvantage in such a trial. Now, stress has been laid on the fact that an officer of one of the American building firms stated incidentally, in the course of a law case on a totally different matter, that these engines were constructed not according to dimensions prescribed from England, but to be equal to certain duty, the sole limits being the load gauge. This does not quite fit in with what had previously been said authoritatively on that head; but I am content to let it pass for the sake of argument. For then I say that the engines, as built by the Baldwin Company for the Midland, were not as tried on the competitive experiments. For, according to the figures given to me at the time by the Baldwin Company, the engines were built to work at a boiler pressure of 180 lb. According to the figures kindly supplied to me at Derby by Mr. S. W. Johnson, they were worked at a limit of 160 lb., *i.e.*, 20 lb. lower. "A Locomotive Engineer" says he "fails to see why this should be otherwise than perfectly fair to the American engine." Very likely that may be so if you are merely comparing one locomotive against another on identical work for the railway's own purposes, but when you base on that comparison the assumption that it has proved American locomotive practice inferior to British, then the deprivation of one engine of 11 per cent. of its whole steam pressure becomes entirely relevant as a factor. If "A Locomotive Engineer" seriously asserts that the abstraction from a locomotive of one-ninth of its whole steam pressure available makes no difference to its efficiency, I can only say his experience differs very widely from mine. Not long ago it occurred to two very fine specimens of British locomotives on different railways, one being the Midland itself, that for reasons of inferior fuel or otherwise, each engine was unable to get up its pressure to within 20 lb. of its proper standard, 170 lb. in one case, 160 lb. in the other. As a consequence, each lost several minutes. I have very full notes of each case. But it is answered that, even allowing that the American engines were working at 20 lb. less than their standard pressure, it would not affect their working expenses in respect of fuel, lubrication, and repairs. Again I say very likely. I do not dispute the point, because I never raised it. I merely said, and say, that a trial on such conditions is no comparative test of American and British practice. On the point that the American engines had a piston stroke 2in. shorter than the British, and than that of most American locomotives employed on similar duty, I based no argument whatever. I contented myself with reciting that fact among the others which combined to make up the complete case.

That engines of that particular design would compare unfavourably with those of Mr. Johnson's design I never for one moment doubted. It is true that, as Mr. Johnson himself stated, "they worked their trains satisfactorily," but they did so, as I should have anticipated, at an undue cost in working expenses. I have always regarded American engines in general as having a tendency to be somewhat wasteful in steam and coal and repairs. I am not now, nor was I in my previous article, defending American practice, or I might say that even this question resolves itself into one of relation. It may suit American engineers better to use a particular class of locomotive, even if it be more expensive in steam and coal and repairs, just as it is deemed preferable to build an engine not intended to last so long as is expected of British machines. Into that I have not as yet entered, nor shall I do so now, although I may at some future time. "A Locomotive Engineer" says that I "enthusiastically quoted" Sir Ernest Paget's statement of the American practice in this latter respect. My "enthusiasm" consisted in remarking that the wisdom or otherwise of that policy is "open to argument." Surely that was a very much qualified form of "enthusiasm." He proceeds to argue upon this issue as if I had declared on the American side, instead of expressly treating the whole question as one "open to argument." Did I care to proceed with any contention on an issue which I had not set up, I might instance the modern Great Eastern practice with regard to breaking up even moderately old engines that no longer suit modern requirements, and I might point to the large number of old engines which are directed in the Midland official rule book to take only twenty-five instead of thirty wagons, thus necessitating six trains being run instead of five; but I have not yet taken any side on this point either, but have contented myself with merely indicating its existence, and so I leave it over for the present. Much, too, might be said as to "A Locomotive Engineer's" remarks about piloting, viz., "that these said engines often come in very handy as pilot engines, when the use of two powerful engines would be wasteful." I could give a good deal of interesting information as to "piloting," from which it would appear that all British locomotive engineers do not agree with him as to the wastefulness of using "two powerful engines" on one train. But this is not germane to the subject of my article, and I cannot possibly stray beyond the original issue. Nor will I go into the question whether British drivers would at first take kindly to American engines, and strive to get the best out of them, as against British competitors. It is a factor which could not be ignored if I were discussing the relative merits of British and American engines as thus tested, and some very curious and interesting colonial experiences might then be adduced. But as I have not raised the point, I decline to be led away from the point I did raise. Consequently I decline to notice the very inaccurate assertion of "A Locomotive Engineer," that any arguments were put

forward by me "as an all-sufficient answer to the proved poorer workmanship of American locomotives, and in disparagement of objects and methods pursued by the locomotive builder in this country." My published writings in THE ENGINEER and elsewhere, are an "all-sufficient answer" to this most inaccurate and unfair allegation. Nor does it seem to me that the same writer strengthens his position by characterising my "arguments" as "specious" and "faulty." That sort of thing is very cheap and very easy, but it is neither scientific nor convincing. It is somewhat diverting to notice the extent to which "A Locomotive Engineer's" contentions are based—by his own admission—on "assumptions" and "round figures"—very round!—and the frequency with which he admits his inability to explain various points on which he feels bound to insist—as in three instances on page 43 (THE ENGINEER, July 12th). But I will not dwell on these little peculiarities.

Were I disposed to sum up the whole question of American *versus* British practice—which is not the issue raised by me as yet—I should say that, while I greatly prefer almost every point in the British method, excepting the smaller dimensions, which are now being remedied on all hands, I feel bound to recognise that American engineers, not being fools, and having a far larger extent of railways to deal with than we have, may probably have sound reasons for adopting the methods which they employ, and of which I personally disapprove. And I might add that those methods have certainly proved preferable in some colonial cases. It may be that American engineers, on their part, as do British engineers on theirs, design and build the sort of locomotive most suitable to local requirements. As to this I express no opinion, but I can easily conceive that each plan may have its advantages which possibly may counterbalance any drawbacks. But, in conclusion, I must insist on again expressing the conviction which I declared in my previous article, that, "Comparing engine with engine on the basis of efficiency per unit of nominal power—reckoning the capacity of the boiler and fire-box, as well as of cylinders and wheels—and also on the basis of performance per unit of nominal power, no locomotive exists in the world that is superior to the British."

IRON FOUNDRIES AND FOUNDRY PRACTICE IN THE UNITED STATES.

(By our Special Commissioner.)

No. XIII.

U.—HOISTS.

AN appliance now in general use is the air-hoist, consisting of a vertical inverted cylinder, having a hook formed on the end of the piston-rod for the attachment of a chain or sling. The compressed air is supplied through a flexible hose, and a lever attached to the valve stem in the cylinder head has pendant chains by which the operations are controlled. The cylinder is ordinarily from 6in. to 24in. diameter, and 4ft. to 8ft. long, using air at 60 lb. to 100 lb. pressure, the smaller machines have a hoisting capacity from 1000 lb. to 2500 lb., consuming 4 cubic feet to 6 cubic feet of free air for a lift of 4ft. A 12in. cylinder will hoist 6000 lb. to 10,000 lb., using 15 to 25 cubic feet of air, and a 16in. cylinder will hoist 10,000 lb. to 20,000 lb. with a consumption of 28 to 42 cubic feet of free air for a hoist of 4ft. Air hoists are used in many of the large foundries already described, and are of universal application. They may be stationary, or carried by travelling cranes, jib cranes, or overhead trolleys, according to the character of the work for which they are required.

In moulding, an air hoist is invaluable for lifting flasks, moulds and cores, drawing patterns, &c. It will do the work with little danger of causing the loss of castings, and with considerable saving in the cost of repairs to the parts handled. The air hoist may also be utilised as a drop for breaking up pig iron, defective castings, &c. For the latter purpose, it will do the work many times faster than a man with a sledge hammer.

Two objections to the ordinary air hoist are: First, a jerking motion—due to compression of the air, which is very objectionable for work requiring great care in handling; and, secondly, a liability to slip, owing to leakage of air past the packing. Where the load must be handled steadily and sustained immovably, an oil-governed air hoist may be used. The piston-rod is hollow, and filled with oil, which flows out through a controlling device during the upward movement of the piston, thereby preventing a rapid or irregular travel of the piston and its load. Such a hoist may be safely used in handling ladles full of melted iron, for which service the ordinary form of hoist would be more or less dangerous. Electric hoists are sometimes used, these resembling small travelling cranes, but operated from the floor, as at the General Electric foundry. These are more positive and reliable in action than the ordinary air hoists.

V.—OVERHEAD TROLLEYS.

For transporting ladles, flasks, patterns, or other material about the shop, or for carrying material from one shop to another, overhead trolley systems are extensively used. These consist of overhead runways, suspended from the roof, and having wheeled trolleys travelling along them. Such systems have been described more particularly in regard to the Walker and Pratt foundry—Figs. 14 and 15; and the Milwaukee foundry—Figs. 22, 23, and 24. The runways are suspended from the roof trusses, usually about 9ft. above the floor. With this system the overhead line is arranged to suit the plan of the foundry and the work for which it is required, spurs or branches being led off to points not served by the main line, such as the sand sheds, cleaning room, flask yard, &c. The flasks, sand, ladles, castings, &c., can thus be handled with much less interference with the work than would be the case if wagons, trucks, or wheelbarrows were used.

The overhead line should never have a dead end or terminus at the cupola, but should extend beyond it, and form a complete loop, so that in case of the tapper failing to close the tapping hole when one ladle is full, this ladle can be moved on and another put in its place. The first one can then be carried away to the pouring floor, without any interference with the one at the spout, or with the empty ladles waiting their turn. Movable sections of the overhead line form points for connecting with diverging lines, while turntables are used at intersections. The telpherage system, with wire cables instead of rigid runways, is also being introduced.

On the overhead line run trolleys or carriers, from which the ladle, casting, &c., is suspended by a bar. Ordinarily, the trolley is not fitted with motive power, but a man on the floor pushes the ladle or casting before him and causes the trolley to run along the line. In the Pawling system the trolley is equipped with electric motors for propelling it along the overhead line, and for driving the hoisting drum. In this case a boy rides in a cage or seat suspended from the trolley, and controls all movements. Electric hoists, chain hoists, or air-cylinder hoists may be suspended from the trolley for lifting the articles to be handled. These are usually operated by means of endless chains or hanging chains. Fig. 58 shows an electric trolley hoist built by the Northern Engineering Works, and running on a rolled steel joist which forms the overhead line.

The pneumatic engine or motor used in so many varieties of pneumatic drills and other tools has been applied to a differential hoist on a trolley which may be

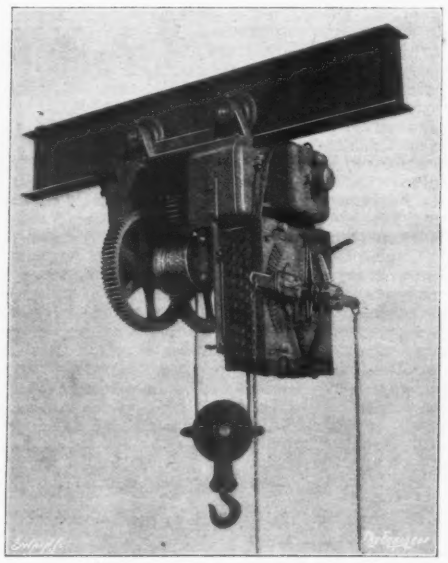


Fig. 58

attached to a crane, or to the runway of an overhead line. The motor runs in oil, as it is not easily accessible for ordinary lubrication. The hoist may have a capacity of hoisting a load of five tons at 10ft. to 35ft. per minute.

In the Coburn trolley system a hollow runway or rectangular section is used, having a slot in the bottom, formed by turning the bottom of each side leg upward and inward, so as to form two grooves, one on each side of the slot. In these grooves run the wheels of the carrier, which is concealed within the runway, while the suspension bar for carrying the load descends through the slot. A chain hoist or other device may be hung from the trolley, and for heavy weights two or more trolleys may be used to suspend a beam to which the hook is attached. The Coburn system is used in a number of foundries, and the Hopedale Machine Company has quite an extensive line, aggregating 3000ft. in length. In this foundry 35 tons of metal are poured daily. The character of the construction varies with the maximum weights to be handled, the character of the work, and the amount of iron to be carried.

In the Brown overhead tram-rail and trolley system, which is used both in England and the United States, the tram-rail is a rolled steel joist secured to the ceiling joists or roof trusses by patent hanger bolts and key fastenings. Junctions with diverging or intersecting lines are made by points or turntables. In the former case one length of the joist is pivoted at the heel, so that its free end can be moved laterally to coincide with the ends of one or other of the diverging lines. In the latter case the turntable has on its under side a piece of the joist, and by turning the table in a horizontal plane this is made to coincide with one or other of the intersecting lines. The point rail and turntable are operated by pendant hand chains, and are so arranged that the trolley cannot run off, even if these devices are misplaced.

The trolleys have wheels running on the lower flanges of the joists. They have triangular steel side plates, with inner bearing plates, the wheels having adjustable bronze bearings in both plates, so that they have inside and outside bearings—an arrangement which tends to reduce the resistance. These bearings are self-oiling, and require lubrication only once in about six months. A special feature is that the wheels are large, the diameter being nearly equal to the depth of the web of the joist. This is made practicable by the form of fastening adopted. To the trolley is hung an ordinary or triplex differential hoist, and the larger sizes may be equipped with a hand-propelling gear operated by an endless chain hanging from a pulley. The dimensions are as follows:—

Capacity. Tons.	Joist. Inches.	Wheel. Inches.	Sharpest curves. Inches.
½	5	4	21
2	8	7	36
5	12	10½	54
10	24	22	100

An electric motor may be used, with a frame suspended from two trolleys. One of these is driven by a motor and gearing, power being taken from a wire by two short trolley arms. An operator's platform is attached to the machine, which is built with a hoisting capacity of one to five tons. Separate motors are used for hoisting and travelling, giving speeds of 10ft. to 50ft. per minute for the former, and 200ft. to 500ft. per minute for the latter. The largest size can pass round curves of 16ft. radius. In the Moyer system the runway is an iron bar, set edgeways, while the trolley has double-flanged wheels running on the upper edge of the bar.

In the Wood Harvester Company's foundry the spouts of the cupolas are very near the floor, and in order to tilt the ladles so as to entirely empty them, the ladles must be raised 6in. above the position occupied while being filled at the cupola. For this purpose the hook is suspended from the trolley by means of two coiled springs 24in. long, made of No. 8 steel wire. A ladle holding sufficient iron to pour three moulds reaches the first mould at the same level at which it left the cupola; the loss in weight by pouring causes the springs to raise the ladle about 3in., and after the second mould is poured the ladle is raised 6in., or enough to enable it to be emptied in pouring the third mould. Without such a device, the metal for the first mould would have to be poured from such a height that it would be liable to cut the gate, causing dirt to fall into the mould and be embedded in the casting. The springs are made of such strength as to just counterbalance the weight of the empty ladle, but they can be made of any desired strength and size.

W.—LIFTS.

For stock lifts serving the charging platforms of the cupolas, hydraulic lifts of different types are very generally used, but with the general adoption of the electric current for lighting and power purposes, the current has been applied also to the operation of the lifts. The Craig-Ridgeway steam hydraulic or air hydraulic system—already described under the heading of "Cranes"—is also applied to stock lifts. The cylinder may be placed either directly below the car, operating it by a direct lift, or it may be placed at some other point, operating the car by hoisting chains or cables.

X.—RAILWAY LINES.

Narrow-gauge lines of railway are, of course, very frequently used in foundries as in other parts of large manufacturing establishments, and may be for shop use only, or forming a part of a railway system extending throughout the works. Some of the foundry plans already given show the arrangement of lines of this kind. In the Hunt system, light flange rails are riveted to steel trough sleepers, forming sections of straight or curved line. The gauge is 21½in. over the rail heads, the wheels having outside flanges for ease in passing curves, where special rails cause the outer wheels to travel on their flanges. This permanent way is laid in the floor, the sleepers being embedded in concrete or gravel, or covered with planking. The wagons are of innumerable types to suit special requirements, and have radial axles. A ladle car on this system was shown in Fig. 50. For shop floors, &c., the permanent way may consist of cast iron plates about 26in. wide grooved to form flangeways for the wheels. Points and crossings are built up in sections. Turntables or turn-plates, on roller or ball bearings, may be used, the surface being flush with the floor.

Another important matter is the connection with ordinary railway lines for bringing materials into the works to the most convenient places, and for conveniently loading heavy castings upon the railway wagons for shipment. Most foundries of importance have railway connections, and the spurs or branches within the works must be laid out to suit the special requirements of each case.

In the new plant of the Allis and Chalmers works at Milwaukee there will be connection with two railways, which will deliever the wagons on special sidings. As the wagons are required they will be taken by the shunting engines of the works to any part of the plant by lines running through the yards and entering the shops. Wagons loaded with machinery, &c., for shipment are sent to the shipping sidings in the same way, and all wagons entering or leaving the works must pass over an automatic weighing machine. The foundry, 220ft. by 900ft., will have an elevated line in the yard along one side, serving the cupola charging platform and sand bins, &c. On the other side, three spurs will enter at right angles to the length of the building. The 70ft. yards between the machine shops, and the 100ft. yard between the ends of the machine shops and the side of the foundry, will be fitted with travelling cranes, so that heavy castings can with great facility be carried to the machine shops and then loaded directly into the railway wagons.

The storage and shipping yard of the Louisville pipe foundry has a Whiting compressed-air gantry travelling crane, operated by three separate motors—for hoisting the load, traversing the trolley, and propelling the crane. The shipping yard of the General Electric Company is served by a Wellman and Seaver electric gantry travelling crane.

THE original rock pressure of the natural gas in the Indiana field in 1886 was 325 lb. to the square inch. At the close of 1900 it averaged 110 lb., a pressure which represents only 34 per cent. of the total original amount sealed up in the rock. The close proximity of the salt water in this rock to the gas will prevent the complete exhaustion of the gas over a large area of this field.

COLONIAL STRUCTURAL WORK.

By A MANUFACTURER.

THAT something is wrong with our colonial structural work everybody acknowledges. For some reason or other our colonial trade—or, at all events, the engineering portion of it—seems inclined to slip away from us. A trade that should from the very nature of things be held exclusively and unquestionably by this country has, through some unpropitious circumstances, or else through unwarrantably bad management on our part, been successfully assailed by the foreigner, and it behoves us to understand the methods by which this has been done, and the causes that allowed such methods to succeed.

What, then, is the present position of affairs? How do we stand, and how do our rivals stand? Why are they succeeding and why are we failing? In order thoroughly to grasp the question, let me recount the methods followed in supplying our many Colonial railway lines with their wants. Briefly the same conditions of supply obtain now as formerly. There are, for quite the major portion of the materials required, standard drawings and a standard specification—both having been evolved by the experience of years, and for that reason, if for no other, both should be perfect of their kind. It is the practice, then, when new work is required, to invite tenders for as many bridges or other work as the requisition is for—these tenders to be based on the said standard drawings and specification. To a certain number of privileged firms, vaguely denominated as being on the "Crown Agents'" lists, a requisition sheet bound together with the specification is sent, and it is intimated that on payment of a certain sum the drawings can be supplied also. In addition to this, the fact that our Government is requiring such and such work is publicly advertised, and firms desirous of tendering are invited to do so. Very few firms, however, outside the charmed list, take the trouble, their efforts, if made, being generally regarded as wasted time. It is a great privilege to be put on the list, and firms who are on generally take care duly to advertise the fact. Much time and patience has generally to be expended by principals before they can print the coveted words on their firms' memorandums and billheads. The tenders are duly sent in and the work awarded. Manufacture and inspection commence, and finally the bridge and tools are shipped to the receiving ports to be erected in position by Government servants. So far so good; this procedure has been the custom for long years, and we have grown thoroughly used to it—neither drawings nor specification surprise us—we have them all almost by heart—we know the peculiarities of the one and the severity of the restrictions of the other, and our conservatism has never yet inquired whether old methods are best, or even whether change is at all desirable—why should we wish to alter the good old ways?

And so things might still have continued had it not been that Government once wanted much work done in a hurry—true, it always wants it in a hurry—is not this fact set forth in every specification issued? And does not the bridge builder always smile at this particular clause, because he knows well the other restrictions he must observe, and that as time is necessary to fulfil these, Government must wait that time; and so he coolly puts down his long-time period of weeks, perhaps months. But for once Government was serious. So serious and resolved was it to obtain a quick delivery that designs were asked for the only stipulations as to drawings being that such and such weights were to be allowed for in calculations of strengths, &c. But the specification was not altered, and the contractor never dreamed of departing from or altering in any way that irreproachable document. He well knew that that would not be allowed. Some tenders were duly sent in, but to every ones's great surprise, when the contracts were allotted, it was found that they had gone out of the country—had been secured by America. Then arose the outcry. It was soon known that foreign enterprise had routed the old conditions, and that the tender had been awarded on special designs to a special specification. The manifest injustice of this hit the English firms very hard.

Yet perhaps the loss of this work may be of direct gain to us. It has, at all events, succeeded in opening the eyes of many people to the possibilities for the trade, were the manufacturer given a little latitude and discretion in his work. For too long has he been hidebound by paper specialists—men who have had mainly a theoretical training, and whose reasoning therefore runs in certain well-defined and prettily enunciated grooves. These people, who seldom stir outside their own offices, have obtained a tight hold of affairs, and impose their conditions, born largely of conjecture and guesswork, upon every piece of work turned out in the country. If, therefore, we take the lesson to heart, much good may be done our structural trade by the sweeping away of red tape, and opportunity will be afforded enterprising firms and individuals to put things where they should be—on a thoroughly businesslike footing.

It will not be denied by those most interested that up to the present Government has had to pay dearly for its work—much more than would have to be paid in the open market for work to satisfy similar conditions. We do not mean by this that Government has been exploited—on the contrary, the class of work it has demanded has been obtained at really very low rates for such work. Its dearness lies in the fact that a cheaper class of work would do, and do just as well, all that is desired. Commercially speaking, "finish" has had to be paid for. It is not too much to say that, were our private firms allowed to make to their own drawings and specifications, certain work costing the Government, say, £15 per ton could be made for £12 10s. per ton, strengths being equal. This is a statement that some may be inclined to cavil at, but from personal knowledge and an all-round survey of the question, it may be affirmed that this is within a very little of the truth. So long as Government work was given out solely in this country such a state of affairs did not greatly matter—our own money was being spent with us—but a very different aspect is assumed directly foreigners try to capture this work. If they are allowed latitude, so must it be allowed us. No home firm loves Government work for itself, and would not be at all averse to see the last of it, hemmed in as it is by such restrictions. But Government work shorn of its vexations, and done in keeping with modern ideas, would be most desirable. How very galling, then, is it for the foreigner to reap the first benefits of this, and only because we never had a chance to show what we could do.

There are many reasons why Government work has been so expensive, and the chief of them will be found by a careful perusal of the specification. We are, however, more immediately concerned with the results of that specification as shown in the manufacturer's cost books. In the first place, then, he must pay more for his material than he would were he engaged on other work. This amount may vary from 5s. to a £1 a ton or more, depending on the size and type of work required. The reason for this is to be found in the large range of sizes of sectional material and the small amounts wanted for each size, and also the very great trouble invariably incurred by the mills before their testings and provings are considered satisfactory by the engineers. Were it properly understood that only by buying the same article in quantities can a really favourable price be obtained, one of the principal factors in high prices would soon be eliminated. It is very easy to design any structure so that standard and readily obtainable sizes are used throughout. As has previously been pointed out, the general design of Crown Agents' drawings cannot be cavilled at. The manufacturer, however, finds fault with the working out of the details. It is evident these are in the hands of men who are mainly theoretical in their training. Possibly this cannot well be avoided—for the man who combines good practical and theoretical knowledge is indeed a rarity—but the effect is to make otherwise simple and inexpensive structures troublesome and costly. In order to ensure the best and the most economical results in any work, it is very plain that the whole design of that work must be compatible with best workshop practice, and that though theory may dictate the leading features and general lines, yet practice must direct the working out and elaboration of these. To the general tendency in these times to neglect this very obvious fact, and to trust entirely to the office-bred man to design our work, must be ascribed the generally prettily conceived and imperfectly digested drawings that accompany specifications. Nothing but experience can teach the most economical ways of building even the plainest of plain web girders. How then shall our indoor man cope with large structures, whose details are most complex? It may be accepted, as a safe rule, that one should never, for the sake of finely-drawn calculations, put in sectional material to sizes that are odd and out of the run of ordinary demand. Such procedure does not prove the competence of the designer in cutting down his metal to the very last fraction, but only succeeds in showing up his ignorance of practical work. Because various section books to be obtained from different firms in this country show these odd sizes, it does not prove that it is proper to use them. The practical man will use those sizes he knows he can obtain most easily and readily, and by the consequent saving of time and worry, will more than counterbalance the fractional difference he may have had to sacrifice in his design. It should be an axiom in every office that never, except under stress of peculiar conditions, should any but ordinary standard market sections be employed in any work.

Second to dearness of material for colonial work, comes expense and worry of manufacture. This is due in part to the design, in part to the specification, and in part to the inspection. The two latter have been previously dealt with. As to the former, somehow or other the drawings our manufacturers have to work to are almost invariably expensive in their treatment of detail. This applies to both Government and outside work. Of the many offices of Victoria-street, Queen Anne's-gate, Great George street, &c., there are but few that regularly send out really sensible working details. As a class our designers do not give that attention to little things necessary to perfection in steel work. We do not quibble with broad ideas, and the principles governing design; these seldom trouble the maker unless obvious errors are committed; but protest must be made against the very often careless manner in which that conception is worked out. The very furthest thing from the mind of the draughtsman or engineer engaged appears to be the expense of his methods here. Great efforts are often made to save weight, to cut down material, and to cheapen work in that manner; but very seldom indeed is it considered that economy should demand anything beyond. Yet the designer knows full well that some contracts let for twice or even three times the amount of others; but he considers that this is due entirely to the type of work quoted for. He expects a roof truss to cost more than a plate girder, but only because it is a roof truss, whereas a roof truss designed specially for economy can often be made under the cost of a plate girder. True it is that broad principles do radically affect cost, but not always to the extent imagined. A design simple in principle is often made most costly by clumsy treatment, whilst an otherwise expensive principle can often be made at moderate cost by judicious handling. It cannot be too strongly insisted on that, if economy is to be secured, the first place must be given to questions affecting the girder yard; and only by most careful knowledge and study of these can the successful designs be evolved.

An exhaustive treatise on the various points to be thus considered would be entirely out of place here, and beyond my present intentions. A few principal factors may only be briefly pointed out. First and foremost, then, cut down the work that has to be sent to the smiths' shop. Now much of our lighter colonial work has a great deal to answer for in this respect. Many times are round bars with forged ends used, when flat ties would have answered equally as well; stiffeners are shown bent to most wonderful shapes and angles; plate and angle connections are most intricately smithed; flange plates are bent in long lengths; main angles do duty also as end angles; small cleats are shown smithed out of all shape; and often steel is treated as though it was wood, and was consequently just as easy to swell out here and flatten in there. All this would never be done if those responsible realised what a difference this means to the girder yard. Work that has to be taken to the fire will always remain costly work, and the chief aim, when economy is an object, should be to delete everything of this nature from the drawings. In structural work all pieces should be capable of being treated cold, and it is oftenest the cheapest way to sacrifice a little lightness in order to secure this.

Second to this should be the care taken to see that all joints are conveniently placed; that no piece is shown so long that an extra charge will have to paid for increased care in rolling; that awkward shapes of gussets, angle plates, webs, and connections generally, entailing great waste to cut them, are avoided; and that the riveting is sensible, possible, and, as far as can be, regular in pitch. All these things, and many more also, are regularly neglected by our designers, the consequence being that British drawings of the day are not as a whole flattering to our business acumen. Our structures are second to none if price is left out of consideration, but they are not, as a rule, conceived in a commercial spirit.

It may be, and frequently is, questioned as to whether estimates are so finely drawn as the foregoing would imply. To this it may be replied that the style and practice of most of our leading engineers is thoroughly understood by most structural firms. The peculiarities and requirements of their various conceptions are known and appreciated, and whereas a Warren girder of, say, 100ft. span would be made for A for £12 per ton, £15 per ton would be required from B. How much more, then, will this be the case with Government colonial work? One stamp has prevailed here for a long time, and it has acquired a very certain reputation. When competition is keen and work is much desired, a design is most minutely examined, and is estimated for entirely on its merits. Only the keenest cutting can succeed in taking work in slack times, and every circumstance is, in properly organised firms, duly taken into account. Every little forging is looked out and separately priced—even rivets are occasionally counted in order to arrive at the probable minimum of cost. Let it not be too hastily assumed that British manufacturers are very much behind the times. Comparatively speaking, it is seldom that they are responsible for the design of work sent out of their yards. By far the major portion—indeed, it may be said practically the whole—of their work is made to drawings prepared by the purchaser or his advisers. The consulting engineer is practically master of the structural situation in this country. The results of this system are plainly to be seen when an enterprising outsider is pitted against us. Ask our manufacturers for designs, and they turn out the stereotyped article that they know by experience is the only one to satisfy their masters—the consultants. Not so the foreigner. He has not experienced the heavy hand of the taskmaster. It has been the custom in his country when work was wanted to appeal for it direct; it has never filtered through the hands of an irresponsible agent, interested only in seeing that he had sufficient strength to do the work required. Consequently the greater portion of the structural work made in his country has been designed in the works office, and it has naturally been to the interest of that office to see that its work was designed in the cheapest manner possible—competition assuring the buyer that weight has not been needlessly thrown away. The net results of such a system must be the gradual weeding out of expensive systems of design and work, and the employment of those methods best calculated to save both time and trouble. A real incentive has here been in action, with what results we may plainly see. The drawing-offices of private firms outside this country are in possession of a great stock of proved working drawings, and the girder yards have corresponding templates ready to hand. So much work is duplicated, and the same things so continually asked for, that manufacture in any particular branch can commence with the "touch of a button." Certain standard loadings are always adopted, and after a few years' work a firm is prepared at a moment's notice to produce designs in all the approved styles, and in very varying spans, to put before the purchaser for his selection. One merit this system is bound to possess—that of great despatch and execution of orders. With us no two bridges are exactly alike. Everything that comes to our hands is altered from its predecessor. Templates and drawings are therefore seldom worth keeping, and as fresh ones must be prepared for each new job, due time must be allowed for this.

So that when our maker is asked for designs by a very needy Government he has to start at the beginning of all things. It is odds against him that he has nothing by him similar to the work required, and he knows he has to please inspectors and satisfy a specification; what wonder, then, is it that his resultant drawings partake of as much of the official character as he can get into them, and that his prices are based on the class of work he knows will be demanded? It is only when he is dealing with private buyers who ask him for both drawings and specification that he has anything like a free hand, and is given the chance to show what he can do. It is a very great question as to whether our present system has really resulted in giving the country better structural work than would have been obtained by dealing direct with the makers, and one not to be enlarged upon here. It has, at all events, been proved that outsiders, with

their different way of managing things, have stolen a march on us.

The present position of affairs, then, is this:—The gradual growth of a number of independent consulting experts with everything in their hands has resulted in a hide-bound system of manufacture in this country which takes away from the maker all responsibility. He has but to work to the drawings and specification in all things, and his work is immediately voted a success. Enterprise he must not possess. Even his tools must please the inspector; if he has what is expected, well and good; if he has not, he must obtain it. It is no use wishing to do the work in any other way—the consultant's office boy is quite competent to teach him how to do everything. Large and small work alike, he is allowed no latitude; and should he desire the alteration of the position of but a single rivet, he must approach the expert with a due sense of the favour he is about to ask. Incentive to betterment, then, he has none. Small wonder, then, is it that he has been content to rub on, so long as he could please the powers that be, and continue to get more of their work. That he would be glad to escape from this, and to pit his wits against his neighbour, is certain. The present state of affairs has for long given him his bread, but signs are evident that the equanimity of all parties is going to be greatly disturbed. Commercialism is about to rule the steel trade at this side of the water as well as the other, and pounds, shillings, and pence will ultimately succeed in obtaining the cheapest work here. No one is, however, dismayed at this. We recognise that it must come, and are quite ready to take our part in the matter.

But whilst things are as at present, the manufacturer is hardly to be blamed when work leaves the country. His immediate reply to charges of slackness has so much truth in it that it cannot well be gainsaid. Up to the present, when foreign competition has had to be faced, our makers have been in the dark as to the conditions upon which their rivals were working. But I believe the day is fast dawning when different systems will prevail, and when it will be necessary for all parties tendering for the same work to observe exactly the same conditions. If, then, work is taken out of our hands there will only be ourselves to blame. We believe that, notwithstanding the great incubus the structural trade has been subject to, there is plenty of enterprise lying dormant, and only needing the opportunity to make itself felt. There are in this country firms of engineers second to none in the world, who, when a freer hand is allowed them, will prove themselves capable of undertaking on their own responsibility engineering enterprises of the first magnitude.

It needs no demonstration to prove that the most suitable structural work, for a new country especially, shall be that work which, while being of maximum strength, shall be of minimum cost both in manufacture, difficulty of transportation to place required, and in erection on site. Unfortunately for us the work at present being supplied does not fulfil these ideals. Its cost of manufacture, as I have shown, is disproportionately high for the class of work; whilst the type generally selected is expensive in shipment and also in erection. As regards cost of transport, the favourite type of America easily carries the palm; pin truss work—very much out of favour in this country—is not surpassed for ease of dismantling, packing, stowing for transport, and re-erection in place. This type of bridgework, first made in this country, has been fostered and improved by the American plan of doing business. Its cheapness, when properly and economically designed, early appealed to the business instincts of a commercial people. It was quickly seen that pin connections would make a much cheaper bridge, span for span, than the riveted type, and efforts were made by the interested firms to obviate as far as possible the inherent weaknesses of the system. In this country its drawbacks, soon recognised, were allowed to stay its evolution for many years; but in the States they were tackled, and pin truss work early became an American feature. Whatever may be said for and against the "American bridge," as it is often termed, regarding pure theory, nothing will explain away the fact that it is unequalled for facility of transport and speed of erection. That the type has reached its furthest development is open to much question, and altered conditions in this country may yet change it somewhat, but its peculiar adaptation for colonial work will always make it a strong favourite where it can be employed.

But whatever the type selected, the first need is cheapness of manufacture; and every type is here capable of much modification. Our ideal colonial bridge should not be "faddy" in any particular, any more than it should be experimental. Every effort should be made to simplify work. And here we must not forget the specification—the greatest "killjoy" ever invented for the maker. This should be so drafted that, whilst its provisions shall ensure the class of work deemed necessary, they shall not bear too hardly where there is no need. Much might be said as to what is relevant and necessary, and doubtless diverse opinions will always exist on this; but a careful and conscientious mindfulness of the main object always in view, and a rigid disregard of everything ulterior to this, would do much towards softening the rigour of many of these documents. Our great present need in this country is for modern ideas in responsible quarters, an abolition of red tape, and greater freedom of action for the manufacturer. When this is brought about, a great incentive and stimulus will be given to the trade, much public money saved, more work consequently given out, and healthy foreign competition will never be feared.

Success of British Manufacturers in South Africa.—The Corporation of Capetown, in spite of the great competition from foreign firms in the electrical industry, have placed a large order for engines and electrical plant in this country. The order for engines has been placed with Messrs. Ferranti, Limited, of Hollinwood, Lancashire, and the dynamo machinery with Dick, Kerr and Co, of Preston, the size of each unit being 1200 horse-power.

THE STEAM MOTOR CAR.

The "Locomobile" or steam motor car made one of its first public appearances at this side of the Atlantic in May, 1900, at the Paris Exhibition. Since that date very large numbers have been sold. In the United States there are, we understand, over three thousand at work. The mechanism of the car—in which words we include the steam generator—presents so many curious and anomalous features that it claims the consideration of engineers. Work is done under conditions which seem almost inimical to its performance. Indeed, so almost paradoxical is the apparatus, that the steam motor pleasure car is less popular perhaps with engineers than with other men. They know so much that they cannot bring themselves to believe in the thing; while the general public having nothing to unlearn, are not oppressed with the same doubts and fears. There are three or four makers of steam motor cars. They all work, however, on nearly the same lines, and when we have described one we may be considered in a pretty full sense of the word to have described them all. Indeed, it would appear that there is only one system of construction and working that satisfies the conditions. Thus, no successful car has, so far as we know, up to the present used a horizontal steam generator or horizontal engine. Nor has any other fuel been found available save "petrol" or light oil, although strenuous efforts are being made, with at least some promise of ultimate success, to use ordinary parafine oil or kerosene lamp oil. The "Locomobile" must not be confounded with any of the earlier or heavier machines using coke or petroleum as fuel. It depends for its success on the development—if we may be permitted the words—of concentrated energy, and the fuel it uses is precisely the same as that used for explosive engines. The locomobile uses a great deal more petrol, but it has advantages which compensate for that fact.

We have already illustrated one form of the car in our impression for November 9th, 1900, and described it in some detail. It has, however, undergone important modifications in general design. We have now selected for illustration the mechanism of one of the latest cars made by the Locomobile Company, of Kensington. In few words, a small vertical boiler, fired with petrol, supplies steam to a pair of little vertical cylinders, which drive a crank shaft carrying in the middle a chain wheel. The chain drives the hind pair of road wheels of the car through a jack-in-the-box compensating gear on the middle of the axle. Beyond jack-in-the-box gear there are no cogged wheels or gearing of any kind. The car will easily run up any hill that can be worked in the ordinary way by horses at eight miles an hour; on the level twenty miles an hour is easily maintained. Concerning this we shall have something more to say presently.

Let us begin with the boiler. This is about 14in. in diameter and 14in. high. The shell is made of a solid drawn copper tube. The ends are flanged out, after two steels rings of the same width are put on the tube. The ends of the boiler are of steel, ¼in. thick. They are riveted to the boiler shell flanges with ⅜in. iron rivets, put in cold. The rivets pass through the end plate, through the copper flange, and through the steel ring named above. The edges of the copper flanges can be used for caulking the joints, coming as they do between two thicknesses of steel. The whole shell is then wound in the lathe like a gun with two layers of piano wire, which has been tested by making it carry a dead-weight of 300 lb. The boiler is traversed from end to end by 300 copper tubes. These are ⅛in. in diameter outside. The water spaces are only about ⅜in. wide. The total heating surface is about 42 square feet. The proper working level of the water is supposed to be about 8in. from the bottom.

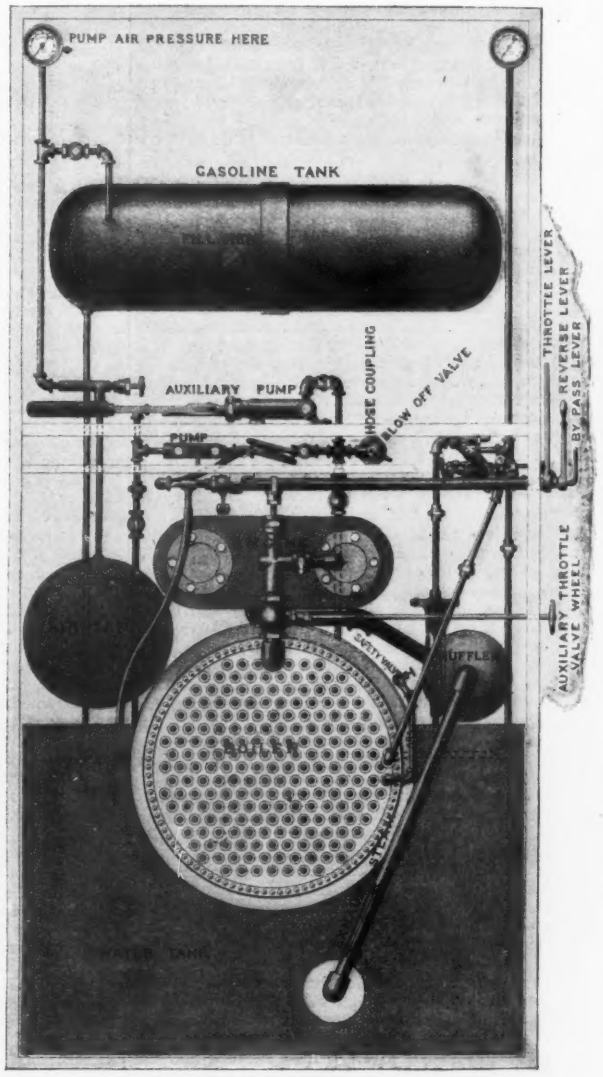


Fig. 1—PLAN OF LOCOMOBILE

Most engineers who have read thus far will stop here to say that a boiler of this kind is a ridiculous thing. It must at one time superheat the steam, at another prime horribly. A couple of days with bad water will ruin it, by filling it with scale and lime deposit. This was our own view. Practical experience has taught us that none of these things take place. The action of the boiler is most peculiar. Whether it is nearly full or more than half empty seems to make no difference. The engine runs without any trouble from either superheating or priming. There never was so accommodating a boiler. But the most noteworthy fact of all is that it can be kept quite clear of scale with the most moderate precautions. The feed ought always to be rain water, and the owners of steam cars usually provide tanks to catch the water from their roofs; but if when at a distance from home ordinary drinking water must be used for lack of rain water, it makes no difference. Any lime deposited appears to be taken off again by the rain water feed when next used. It is essential that the boiler should be quite emptied at the end of the day's work, by blowing it down when the pressure has fallen to about 50 lb. In spite of the shortness of the vertical fire tubes the boiler is very economical, the products of combustion passing away at a temperature little over that of the water in the boiler. We have before now called attention in these pages to the well-proved fact that if only a flue tube is small enough in diameter, little or no heat will escape to waste through it; and we have described, indeed, a fire-tube boiler with tubes only 8in. long, which not only evaporated its own weight—one ton—of water per hour, but did the work with one-eighth of a ton of Welsh coal. The small tubes in the locomotive boiler are peculiarly well situated, because the heat is perfectly clean. There is no trace of smoke or soot, the combustion being perfect. Indeed, if it were not, the car could not be worked at all. So far as we can see, there is no reason whatever why this system of boiler construction should not be extended in other directions. Be this as it may, the fact remains that in the locomobile we have a steam generator which does not give trouble in any way; in fact, it is an ideal source of power. No doubt if it were supplied with muddy water the results would be evil; but to show what the boiler will stand, we have heard of one which was allowed to run short of water on five different occasions. It was "burned," and leaked each time. The tubes were re-drifted, one or two replaced, and the boiler is none the worse. As to the pressure that it will endure, we are informed that one tested to destruction bore 1200 lb., and then a couple of the tubes collapsed and brought the experiment to an end.

We do not propose to write a minute description of the locomobile, but rather to consider its performance. The engraving Fig. 1 serves very clearly to illustrate the general arrangement of the mechanism. It is necessary, however, now to say something in detail of the way in which steam is generated. Under the boiler is placed a flat vessel about 1½in. deep, stamped out of sheet steel, the same diameter as the boiler, and traversed by a very large number of ⅛in. tubes, about 1in. apart. These tubes resemble stays, securing the top and bottom of the "pan" or "burner" together; round each is drilled a great many holes about $\frac{1}{20}$in. in diameter. There are some 3000 of these holes in all. The fuel used is, as we have said, petrol—the same light spirit that is exploded with air in the cylinders of the normal motor cars. It is stored in a copper cylinder under the footboard, and has a pressure of air on top of it pumped in to about 35 lb. on the square inch. This suffices to eject the spirit through a very fine nozzle into a tube which traverses the boiler and the smoke-box, and in which the petrol is volatilised, and is then discharged as gas, into the furnace or pan which we have just described, thence rising through the rings of small holes round the half-inch tubes. These last supply an abundance of air for circulation, and the petrol burns

with an intensely hot blue smokeless flame. There is an automatic regulator provided to cut off the petrol supply when the steam pressure reaches about 200 lb.

The engines are illustrated in Fig. 2. They take the place of a man on a bicycle, the pedals being replaced by cranks. It is noteworthy that all the bearings are fitted with balls. At different times attempts have been made to fit ball bearings to the big ends of connecting-rods for high-speed engines. But it has been found impossible to prevent knocks. In the little engines of the locomobile the ball bearings give no more trouble than they do in a bicycle. The worst that can happen is the breaking of a ball; but they are not more liable to break in the locomobile than in the bicycle. The engine frames are drop forgings, the cylinders of cast iron 2¼in. diameter and 4in. stroke. The engines will run at any speed from a dozen revolutions per minute up to 600. About half that rate gives a good road pace. The chain gear is proportioned about 2·5 to 1. Taking the effective diameter of the road wheels at 28in., the car will advance, say, 7ft. per revolution, that is, 7ft. for every 2·5 revolutions of the engines, or for 250 revolutions of the engine per minute 700ft. for the car, or very nearly eight miles an hour. At 500 revolutions per minute of the engine the car will make sixteen miles an hour, a speed very easily maintained on a good road, fairly level, with two persons.

The pistons are of cast iron, screwed and rivetted on the piston-rods. The slide valves are quite plain, like those of a locomotive engine, and of cast iron. The whole engine, it will be seen from Fig. 2, is as simple as possible. The area of each piston is, within a fraction, 4 square inches. At 300 revolutions per minute the piston speed is 200ft. This, with a mean effective pressure of 100 lb. per square inch, gives about 2·4 horse-power for each cylinder. The boiler pressure is 180 lb., so that the engines, even allow

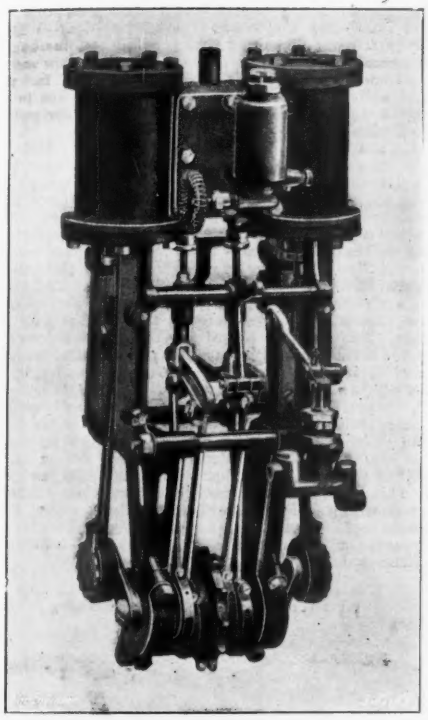


Fig. 2—ENGINES OF LOCOMOBILE

ing for a moderate cut-off, will easily indicate 4 to 4·5 horse-power collectively.

As we have said, our intention has not been to describe the car minutely—that has often been done in other journals—but to treat of some of its salient peculiarities as a self-propelled vehicle. One of the most prominent of these is that there is no vibration and no noise. The locomobile is as silent as a bicycle; once steam has been got up there is no further trouble. The car will wait patiently at the door until the rider moves one small handle which opens the throttle and another which shifts the link. The automatic cut-off checks the supply of petrol as soon as the steam is nearly blowing off. In all this the locomobile is an ideal car, in the strongest possible contrast to the noisy, vibrating car fitted with an explosive engine. Another noteworthy feature is the small power required. The locomobile weighs about 700 lb. in running order, and fitted to carry two persons. This is about half the weight of the explosive engine motor car to carry two. The latter has to be fitted with gear for three or four speeds; the locomobile has no gearing whatever. The consequent absence of friction tells to some purpose, for on a good road two horse-power will run the vehicle at the same speed as a pair of smart trotting horses. It is the only power-driven vehicle with which we are acquainted in which a mechanical horse-power can do as much as an animal horse-power.

The drawbacks to the use of the steam car have to be considered. As far as upkeep is concerned it ought not to cost more than the motor car. Tires are, of course, in both, the principal item. The cost of petrol in the locomobile is much greater than in the motor car, and may be taken as about 1d. per mile. The locomobile is, for this reason, not well adapted for touring, and there is besides the difficulty about getting water. But for the purpose of, say, the medical man, who has to pay a round of visits every day representing some twenty miles or so, the locomobile leaves little to be desired. In other words, the steam car is a mechanical "horse and trap," and will discharge the same duties far more economically, and at a speed which no horse can reach. It is a very curious and ingenious adaptation of steam power to the purpose of locomotion; and its inception represented no little audacity on the part of the maker; as much, indeed, as that displayed by Trevithick when he made a steam car for common roads. The locomobile comes from the United States, but it is not the first steam pleasure car that has been made to work with liquid fuel. Some twenty-five years ago Mr. Blackburn invented, patented, and made a most ingenious steam dog-cart, with a coil boiler, a three-cylinder engine, and liquid fuel burned with a forced blast; but as the vehicle could not be used without breaking the law, nothing came of the invention.

TRAVEL IN AIR.

By I. LANCASTER.

A SUBJECT of world-wide interest, that persists in spite of failure, is found in artificial air navigation. All schemes, before and since Montgolfier, fail, and the great balloon is unfitted to the task, however well it may do part of the work. It is deficient in mobility; it is controlled by currents, and goes slow.

The birds are past-masters in the art. They inhabit the atmosphere in untold multitudes; some species, such as the condor and frigate bird, may be said to live in the air. The latter will not touch a rigid support for a month, stealing their food from fish-hawks, and floating in great circles to the height of a mile or more while it is digested. The condor carries its 20 lb., with an additional 10 lb. of freshly gorged carrion, to an altitude of three miles, and serenely waits for an empty stomach to return to earth. The great whooping crane stretches its wings at Winnipeg, and at the elevation of a mile migrates to some lone island on the shores of the Gulf of Mexico, and a field glass and close and long attention will detect no wing motion in its straight line flight, or in the endless circles of the frigate bird and condor.

Is there something wrong? Is there a mistake somewhere? If a 30 lb. condor can circle around for six days, three miles high in the air, why cannot a man? If the great buzzards anywhere about the shores of the Caribbean Sea can be seen 300 days in the year floating in the sea breeze over the beaches, on the look-out for dead fish, without a wing motion for hours, why cannot a man float in that same wind? He can encase himself in surfaces as large—why must his attempts end in failure?

But this is not all. How do the birds do it? What is the motive power of a quiescent bird that moves it through air resistance, and keeps its heavy body from falling? Nobody knows. Science is as dumb as the Sphinx when confronted by a soaring bird, and common sense is baffled. The bird carries no engine with it. It does not move the flappers it has after it gets well to going. Its moving parts seem to be of use only to get it off some unknown dead centre. Once going, it is a Genii of the Lamp, violating all known mechanical laws, persistently doing work in holding up a heavy body, and overcoming atmospheric resistance at the rate of 50ft. per second without discoverable expenditure of energy.

A condor will alight on a carcase after being six days in the air, and go to work as if it had enjoyed a long rest. To say that there is always wind where the birds are is no help. Why cannot a man float in wind as well as a bird? Any wind, or no wind at all, is all one to the bird. Does the weight of a man act differently from that of a bird, that he comes down so promptly?

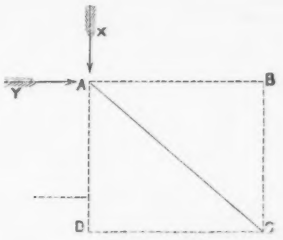
There must be a solution of this matter if one could only hit upon it, and the time has arrived when it would be wise to examine our foundations. Is there something hidden, that no one sees, in the activities of this case? Take the flight of a crane: how is that motion produced? From whence comes the energy consumed in disturbing and driving away the air in the path of the bird? It may be that science does not see it all. There may be some new idea, not yet discovered, involved in the case; and it might be important to the well-being of mankind to get at that idea, and see if there be good in it.

I propose to examine this action of the bird, and disclose the concealed mechanical work in progress, if such be found. I ask the reader to keep step with me in this investigation. I do not propose to make a statement that is not seen to be true on making it. The principles of mechanics are all fixed for us beforehand, and I do not introduce a novel suggestion in reference to those principles. I can find nothing new in regard to the mechanical analysis of this case. It is all as old as the time of Newton. His third law, dealing with the equality and opposition of action and reaction that lies at the foundation of the subject, is a common school study, and understood by everyone. We all know about gravity. The text-books have it right, beyond cavil, so that our task ought to be an easy one. It is easy. I am convinced that the reader will be more surprised at the inevitable character of the result than at any other feature it may present.

The first thing we notice is the uniform motion of fixed wing flight. The bird does not move as a stone falls, faster and faster. There is no acceleration. Its speed varies from 35ft. to 75ft. per second, averaging about 50ft. per second. We next observe that its wing expanse, including body and tail feathers, approximates a plane, and in the act of flight this plane is inclined from three to ten degrees from level, highest in front. The bird moves in free air, and the problem is one of a rigid body moving in a resisting medium. Let us dismiss all thought that the bird is alive, and get at the case in the simplest way possible, as a purely mechanical action. We will neglect gravity, and consider the bird as a plane devoid of thickness other than what is required to hold it in the mind, and of the same specific gravity as the air it displaces, when it will be at rest with the air wherever placed.

We will apply forces to this plane, so as to produce the level line of uniform flight in the most economical manner, thus learning what forces, and how applied, will do the work; and afterwards we can introduce weight and thickness, or, in other words, make a bird of it. Elaborate experiments have been conducted to get the soaring plane, but we have no need of any of them. We will get such action at once from the definition of a plane without any experiment whatever.

What is a plane? In a vacuum it is the same as a particle, or stone, or other heavy body, and can be so treated. If a force Y be applied to it that moves it to B from A in one second, and another X that moves it to D from A in the same time, it will pass to C, on a resultant. If the forces are equal, the resultant will be the diagonal of a square. Inertia is a universal reaction, in all directions alike, so that any action, in any direction or of any amount, can find a reaction in it. In moving bodies only the resultant is visible. The motions that produce the resultant are not seen without special contrivances to make them obvious. But where motion is in air the case is different. In vacua, forces accelerate the plane



while in air, motion soon becomes uniform. The force X will act against air pressure under the plane when applied perpendicular to its sides, or normal to it, and move it to a uniform speed, which will continue indefinitely. The force Y, parallel to the plane, will move against friction to a speed of uniformity; X encounters great resistance; Y has small resistance to work against, so small that authorities consider it negligible. Normal motion would then be slow, while parallel motion would be fast, when related to each other. We will suppose the force X to move the plane at the rate of 10ft. in one second, and Y to move it 50ft. in one second; it would then pass on the resultant A, D, quite a different diagram from motion in a vacuum.

Pressure and friction are the only reactions belonging to the plane in uniform motion. They are fixed by the law of fluids. Friction is along the surface, or parallel to it, while pressure is perpendicular to the surface, or normal to it.

It follows at once that pressure reaction is confined to a single straight line, which we may term the normal for convenience; while friction is confined to any line along the surface in any direction. Then, from the opposite character of action and reaction, it is seen that forces producing pressure must act in the normal in a single direction only, while forces producing friction may act along the surface in any direction.

When a plane is in motion in free air, if pressure is developed, we know that a normal force is acting. If friction is developed we know there is a parallel force acting, and the direction of that force is the same as the motion of the plane. Get a clear mental image of the three reactions. Inertia is a universal reaction determined by the direction of the action in each case. Friction is limited to the plane of the surfaces, but can occur in any direction in that plane; while pressure is confined to a single straight line. There is a profound difference in the qualities of these reactions, and without they are understood the soaring activity must remain inscrutable. A force, the text-books tell us, is completely described when its amount and direction are given. As inertia is left out of the case, the direction of the forces acting on a plane are known, leaving the amount only to be determined. A plane can move in two directions only in free air without acceleration. It can move on the normal against pressure, or parallel to itself against friction, or both ways at once, when its visible path will be a resultant; and there is no other motion possible.

A denial of this proposition involves absurdity, for the reason that any other action would be without a reaction. But the important feature is yet to be noticed. It is obvious that inertia may have components. Inertia may have a resultant. Any number of forces may act upon a body simultaneously against inertia, when the resultant would be a composition. No matter how many forces act, nor in how many directions, they would all find a resultant and move the body. Friction may have a resultant, but, unlike inertia, it is confined to a direction along the plane. It is not universal. Friction may be a composition of forces, therefore, and have components that are parallel to the plane. But pressure can have no component. When pressure appears it is the product of a single force, or, in other words, of a force or forces acting in the same straight line, in the same direction. The pressure stress is not a composition, and, from the nature of the case, cannot be. That which has no parts cannot be separated into parts. Co-operating forces are not components. All imaginable components must be in the same straight line, since there is no reaction elsewhere. There is not the least reason for search to discover the source of pressure. It is a single, undivided action, against a reaction located in a single straight line, and that line is perpendicular to the surface producing the pressure.

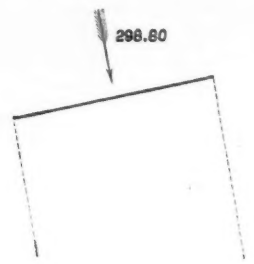
I fear there has been wild work in this region. We have gone far enough to see that the uniform motion of a plane in free air is one of the most direct and simple activities known to Nature. It is much less complicated than an ordinary grindstone. There can be but three motions, two against the reactions, and one resultant, and we will now apply numerical values, and note the result.

Suppose the plane placed on an inclination of 5 deg. from level, and any force, however arbitrary—say, 298·80 lb.—applied to its upper side, perpendicular to it, or in the normal. The plane would move on the normal to uniform speed, when the air disturbances under the surface would equal the total force. We will suppose the surface to be of such dimensions that uniform motion will be at the rate of 10ft. per second, measured vertically.

The rigid plane would produce a pressure plane of condensed air of the same shape and size as itself, upon which it would rest. Each second there would be developed an amount of energy equal to 298·80 lb. moving 10ft. in that time, constantly renewed and wasted.

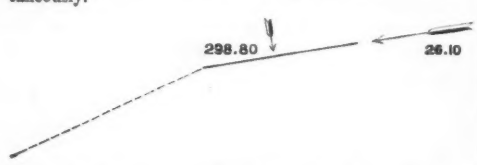
If all this energy could be utilised, it would be enough to push the 298·80 lb. back on the normal to the starting point.

There is no parallel motion, and no friction excepting along the underside in all directions, which does not tend to move



the plane. It will reach the earth on the normal and come to rest. Dismissing this force, we will employ another of 26·10 lb. against the high edge parallel to the plane.

Motion will now be against friction, and high speed will result. We will suppose uniform motion to be at the rate of 10ft. per second, measured vertically, which would approximate 50ft. per second on the incline. We have the same plane and much less force, but more speed, in consequence of the small resistance. We will now apply both force simultaneously.



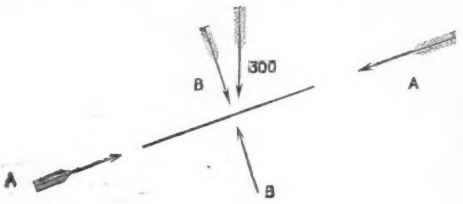
The plane will move against both pressure and friction on the resultant, and reach the ground at a point between the other two places. Nothing could be more devoid of complexity. The stresses are 90 deg. apart. Their product is completely different, and there is no confusion in any of it. The plane slips over the pressure plane against friction to its place of rest on the ground. The air beneath the plane would not be so much condensed during parallel motion, but a larger amount would be acted upon, the plane resting on the air plane at uniform motion the same in either case. The almost perfect elasticity and mobility of the atmosphere would permit the two motions to proceed simultaneously, with no more interference than when each acted alone. The 26·10 lb. has nothing to do with the 298·80 lb.; they work independently and at different tasks.

Suppose that we now wish to make this plane, acted upon by these forces, soar. What additional force or forces must we use, and how shall they be applied? Let us pay no attention to the normal force and motion, but permit that action to continue unchanged. Our object is to get a level resultant and stop the downward slanting one, and if we can do it by working on parallel motion, we will encounter less force in opposition. If we apply a force of 26·10 lb. against the lower edge, opposite the parallel force of the same amount, it will be neutralised, and the plane will come down on the normal. How much more must we apply in the same direction to drive the plane on the upward slant, at the rate of 10ft. per second, measured vertically, which would give the soaring resultant? Evidently another 26·10 lb.; since friction is the only resistance met with it is indifferent whether the plane moves up or down.

We now have the soaring plane, as shown in the following diagram. Self-evident statements make up what has been

said from the beginning of this paper, and we have obtained a result that has the appearance of absurdity. Can 52·20 lb. sustain 298·80 lb., and carry it indefinitely on a horizontal path at the rate of 50ft. per second in free air? It does certainly look like it. If such is the case, we have the long sought perpetual motion before us. We have work done without the expenditure of energy, which is unthinkable, and it is incumbent on us to be attentive to the meaning of words. In fact, the 298·80 lb. is not "sustained." It is moving down on the normal during every instant of soaring motion. If it were not the plane would mount the air rapidly, and be l st to sight. Normal motion is what holds the plane level. The soaring line is a resultant caused by the simultaneous action of both forces, and no more inevitable, reasonable, direct, or interesting activity is known to Nature.

We will now introduce gravity by supposing the plane to weigh 300 lb. This amount is taken to identify the case with



a soaring device of 150 lb., and the operator enclosed within it another 150 lb., and the diagram is given. The two reactions of the plane are on A A and B B, while the applied force is in the direction of neither, but 5 deg. away from pressure and 85 deg. away from friction. It is evident that the greater part of the force would go over 5 deg. to pressure, leaving a small part to act against friction. How shall we determine the exact amount that goes against each? How do we get the pressure that a package of sugar will make on a scale pan? By setting it on the pan and weighing it—a thing often done. We get at the reaction of the pan and the action of the sugar at one operation. The entire amount of gravity in such cases goes against a single reaction; here we have two. Hang up the plane on two strings, one of them 5 deg. from vertical, and the other 5 deg. from horizontal, and weigh the stresses. Treat it as the air plane of pressure, and friction treats it, and the parts are found.

The normal factor of weight is 298·80 lb., and the parallel factor is 26·10 lb., and we have our first case in action again. We did not change anything when weight was taken; 52·20 lb. makes a soaring plane of it, as in the other case.

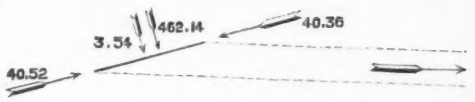
Weight is an oblique force when an inclined plane is used, and, from the nature of the case, cannot act, since there is no oblique reaction. No oblique motion of a plane is possible. It does not move without something moves it, and its reactions determine its motions. But the perpetual motion phantasy stalks into our presence now with a diabolical leer. Can a heavy body do enough work in falling to not only lift it back to its starting point, but to carry it at the rate of 50ft. per second horizontally? For there is 298·80 lb. of pressure going to waste, and it only takes 52·20 lb. to push the plan to the resultant, which leaves 246·60 lb. wasted each second. We did not get the parallel force of soaring from the condensations, it is true, but a soaring bird does do so, as I will presently show, and please notice the fact that these are on hand to be utilised by any suitable device.

Other methods are employed to get the soaring plane than those here detailed, and I wish to give the reader the benefit of them, since they are endorsed by good authority. Mr. S. P. Langley, in his Smithsonian book, "Experiments in Aërodynamics," gives what may be called the "scientific" process, which is fortified by well-conducted experiments, and by "formula which is immediately derived from the fundamental principles of mechanics, and appears to involve no assumption whatever." On page 37 he gives the soaring plane by taking a weight of 464 grammes. This is multiplied by the tangent of 5 deg. for a plane of that inclination, giving 40·69 grammes. He then uses total weight for the vertical component of pressure, and 40·69 grammes for the horizontal component, and the diagram follows. It is supported by experimental results that the mathematical treatment is supposed to verify.

The question was asked at the outset if error existed in the treatment of this case. It is reasonable to suppose that this presentation has kept the human race out of the air for the past century. It is the explanation of the action that works injury. It is almost superfluous to point out its untenable character, after what has been said, but no blame can be visited upon Mr. Langley. The implications of his treatment would be accepted by everybody, for the crust of custom had rigidly encased the method of dealing with gravity as a working power.

Bearing in mind that soaring motion is uniform, containing no inertia acceleration, it is seen at once that neither of the alleged components can find a reaction, since pressure is 5 deg. away from vertical and 85 deg. from horizontal and friction 85 deg. from vertical and 5 deg. from horizontal, and the plane cannot move. It is equally obvious that the forces, being components of pressure, are employed against pressure, that is to say, they both move the plane on the normal. If the plane soars, there must be friction, and there is no action to make it, since it is 90 deg. away from normal, and total action is against pressure. It is asserted that 40·69 grammes measures head resistance or "resistance to advance." But there is no pressure against advance. The only resistance to advance is friction; pressure is normal only.

The final error consists in treating the pressure stress as a composition of forces, where, from the nature of the case, it can have no component. As already stated, both applied forces are at once split into unequal factors to get them in the direction of their reactions. The large factor goes, of course, to the reaction nearest to it. Multiplying each force by the sine and cosine of 5 deg., the two factors are found more easily than by weighing each of them, since the mathematics of a weight resting on an inclined plane exactly applies, and the diagram follows.



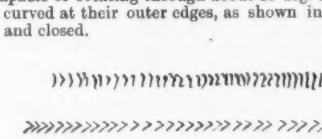
The sine of 5 deg. is ·996, and the cosine ·087. We get 462·14 grammes against pressure, and 40·36 against friction, from weight; and 3·54 grammes against pressure, and 40·52 against friction, from the horizontal component. Adding the pressure factors, and subtracting the friction factors, we get 465·68 grammes for the normal factor, and ·16 for the parallel factor, up the plane, against friction, and it will soar, if friction be estimated small enough.

Mr. Langley evidently had a total misconception of his experimental facts. He had the soaring plane, and it was no such paradoxical monster as he thought it was. No wonder that high speeds sustained weight with less expenditure of energy than low speeds. The lower the angle of inclination of plane, the higher the speed must be to keep it level and the less will be the parallel factor, which is all the weight that is "sustained." The small parallel factor is all the weight that is lifted in soaring flight.

I am entirely aware of the far-reaching implications of this examination, for it makes of weight a continuous motive power, in positive contradiction of many accepted phrases to the contrary. Can man take advantage of this plane and air action to translate himself through the air? This problem is before the attention, but I do not propose to deal with it, asking simply, as a matter of fact, how the birds do it.

I have been trying to discover the exact structure of a bird's surfaces which enables it to get the soaring force from the air pressure under its wings for the past fifteen years. The task seemed hopeless, until accident settled the case. I had located in the foot-hills of the Flat Top Mountains of Colorado, in the dry air of that region, to prosecute my task, where the yellow-tailed hawks that were admirable soaring birds were abundant. A precipitous cliff, 1000ft. high, was near, from which I floated all sorts of surfaces, and year after year the quest went on. A furious forest fire had filled the air with smoke and ashes, and the odour of burning wood was in evidence for months. I had killed a large hawk and was examining its feathers, when a stain was detected on the sides of the quill, between the spicules, that was not before seen. A small magnifier gave it the appearance of discolorations about the throat of a dust exhaust in a planing mill. A microscope was at once procured, with an outfit of objectives from 60 to 600 diameters, and in an hour's time I knew more about bird flight than twenty-five years of study had given me. The discolorations extended along each spicule between the plates. The downy filaments filling the double wall structure of the wings were stained in the same unusual manner. This stain, when scraped off and examined, resembled soot from a stove pipe, showing that the air had been going through the wing in an incessant stream, carrying the smoke and carbon particles of the fire with it. I had been the slave of preconceived ideas. I had been trying to find something that would satisfy my textual and visual faculties. What I really needed was something that satisfied the mechanical requirements of air under pressure that would throw enough normal energy over 90 deg. against the parallel factor of weight, and friction, to slip the bird up the incline to the resultant of flight. And this brings me to the device that soars the bird.

What is a feather? It is an air engine, and the bird surfaces are made of them. They have been looked upon as a light, flexible material for making an extended surface impervious to air, that would readily fold upon itself, and their exquisite mechanical structure has been overlooked. They consist of a quill and two vanes, made up of spicules, between which are the plates. I have never seen a complete description, but Newton's "Dictionary of Birds" and the "Micrographical Dictionary" give the essential parts. The plates cross a channel, about $\frac{1}{40}$in. wide, made by the spicules. These channels are open through the thickness of the feather. The plates are hinged to the spicules at one end only, the other terminating in hair-like serrated appendages which lock into each other, lapping over themselves in the centre of the channel. There are about 1000 of them to the inch, or practically innumerable, and they are located at the outer surface, filling about the one-fifth part of the depth of the channel. They are about $\frac{1}{2000}$in. thick, as nearly as an amateur with the microscope could determine, so that $\frac{1}{10}$ of the space of the channels is open to the passage of air. Thin as they are, they are ponderous when examined edgewise with good specimens of the goldbeaters' art. They are capable of rotating through about 25 deg. and are beautifully curved at their outer edges, as shown in the diagram, open and closed.



A few hours' work with a microscope will teach more about these devices than pages of description. The living bird must be used to get motion of spicules, dependent on motion of wing, and patience is required if the large hawks are used. The plates vary in this rotating mobility in different birds, the wild goose having little of it and the frigate birds very much of it. All birds have practically the same number to the inch, a small snow bird not varying from a whooping crane.

The curved edges of the plates are to the rear in the extended wing, the front vane of the great terminals that meet the air edgewise being abhorted. The mechanical service of the plates is obvious. The curve impinges against the air current through the feathers and drives the bird to the front. Pressure produced by the normal factor of weight is thus made to serve as the motive power of flight.

Nature never invents, but she is a great modifier. A feather is a modified hair. A hair is a modified plant. A plant is a modified crystal. Where the modification first began none seems to know. The fine work of a feather might be predicted when a hair was given to make it, but the inference need not be made that nothing but fine work would do. If man must use 1000 to the inch the case is hopeless, but I have obtained excellent results with no more than 25 to the inch, and an artificial surface may be possible that would excel the natural one, so far as flight was concerned. The action is like that of an ordinary windmill, where the wind impinges on the inclined vanes, and for ordinary fixed wind flight this pressure action is adequate.

The lover of Nature who is familiar with wilds unfrequented by men may witness activities seldom seen in populous places, and the struggle for life between a Wilson's hawk and yellow-hammer on the Colorado Mountains indicates the possession of some mechanical energy greater than can be produced by pressure action. A frigate bird of our southern coasts can move vertically upwards for half a mile, at a velocity of 100ft. per second, with no visible wing motion whatever. There is a spiral configuration of the plates where they meet in the centre of the channel, which, possibly combined with the pressure action, may augment the forward thrust by introducing some molecular energy into the case. These very curious and novel exhibitions of motion still require explanation, and it may be found that the ordinary equilibrium pressure of the atmosphere of 15 lb. to the square inch may be upset by this fine plate work mechanism.

A NEW OIL GAS GENERATOR.

WE recently had an opportunity of seeing at work in the engine-room of the Technical Department of University College, Sheffield, the Moorwood-Bennett carburetter. This apparatus is being put upon the market by Moorwood, Sons and Co., Limited, of Sheffield, and is for use in conjunction with ordinary gas or oil engines in such a manner as to allow of the employment of ordinary oils of high-flash point. For some considerable time this has been under test by Professor Ripper connected to a 9 brake horse-power Crossley gas engine, and has given some excellent results. The engine has a cylinder 6·7in. diameter, a 15in. stroke, and its rated speed is 250. The general arrangement of the carburetter is shown diagrammatically in the annexed engraving—Fig. 1—while the whole engine with the carburetter and the brake arrangement, with which Professor Ripper's tests were made attached, is shown in Fig. 2. The carburetter consists of a closed cylindrical vessel, the lower part, A, of which has two openings, B and C, one being connected to the exhaust from the cylinder of the engine, the other to the atmosphere. The upper part, D, of this vessel is in connection with the engine cylinder through the pipe E. There are two concentric cylinders inside the cylinder A, the larger of the two, F, being in communication with an oil reservoir G by means of a connecting pipe. This cylinder terminates with a cover in the portion D, but it is perforated with holes, so that the two cylinders are in communication. The innermost cylinder H is open to the air through the perforations J, shown at the top. The lower end, which descends nearly to the bottom of cylinder F, is shown somewhat enlarged in the figure at the side. It is furnished with a flange or disc K, and inside it can slide a tube with perforations M and a flange L at the bottom. The distance this tube slides into H is regulated by the spindle N, which has a screw and hand wheel at its top. The perforations M can either be closed by the tube being drawn up, or they can be open as shown, or be uncovered to any intermediate extent desirable. The action of the apparatus may now be understood. The vacuum in the engine cylinder sucks air through the holes J down through the oil in H and through the openings M, whence it rises through the oil in F and finds its way, highly charged with oil vapour, to the cylinder. It will be remembered that the exhaust gases from the engine are led into the jacket A. These warm up the oil, with the result that the drawing of air through it produces a vapour which may be employed in an engine with excellent results. With the Crossley engine already mentioned Professor Ripper carried out a long series of trials under brake, the brake being of a special form of his own devising. In the report upon these tests, and in personal conversation with ourselves, he spoke most highly of this carburetter. He considers it a practical success, and that it provides a means of converting any type of gas engine into an efficient oil engine without any structural alterations of the engine. As showing what an increase of power is obtained by using this carburetter with a gas engine, Professor Ripper says that whereas the engine is rated at 9 brake horse-power as a gas engine, it has run for long periods at 14 brake horse-power with the Moorwood-Bennett carburetter attached to it, the mean effective pressure on the cylinder being 98 lb. per square inch. Russoline oil, amongst many others, was used during the trials, and—as showing the efficiency obtained—in a consumption test made at 10·5 brake horse-power, the consumption of this oil was 0·53 pint per brake horse-power per hour. The specific gravity of this oil was ·82, and the flash point 80 deg. Fah.

As originally invented there was used, in conjunction with the carburetter, an oil separator of a special design, which is shown in Fig. 3. The oil vapour and air entered this apparatus through the pipe *a*, which had communication with the vessel *b* through the holes *c*. The vapour had to traverse all down the outside of the cylinder *d* and up inside it, in order to reach the top of the pipe *e*, and thence to the cylinder of the engine. Any oil which may have gone over in liquid form will be caught in the bottom of *d*, and may be drawn off. As a matter of fact, we understand that this was omitted from the engine as we saw it running. A great feature about the apparatus is the fact that practically all the by-products in the oil are prevented from entering the cylinder, and only the constituents which will be wholly converted into gas on combustion allowed to pass through. In other words, the oil vapour is, so we are informed, passed forward to the engine as a clean explosive mixture, leaving behind in the vapour generator, or carburetter, all the objectionable by-products, which would, were their presence allowed, cause clogging of the cylinder and valves. The deposit or residue may be drawn off from the carburetter, while the engine itself remains clean. We were informed by Professor Ripper that this cleanness of the engine and its valves is very noticeable. One of the conditions which this gentleman imposed during his tests was that the engine should run for five consecutive days from 9 a.m. to 5 p.m. at full load without having anything done to it. It appears to have quite fulfilled the conditions of this test, and on being opened up afterwards to have been quite clean. It also appears that the engine behaved well with a variety of oils, any ordinary lighting oil as purchased in the oil shops giving good results.

From our own experience we can say that the engine started up and ran well during the whole of our visit at various loads and at different speeds, and that the adjustment of the supply of oil was readily made by hand. We also had a plug removed and examined the exhaust while the engine was running, failing to find any signs of deposit. The command over the speed, which is given by means of the regulating devices, was excellent, the possible variation being over a long range. We may add that on the engine as we saw it at work, and as it had gone through all its tests, there were certain arrangements the nature of which were, for the reason that certain of the patents were still pending, not explained to us, but which, we were informed, had proved highly satisfactory.

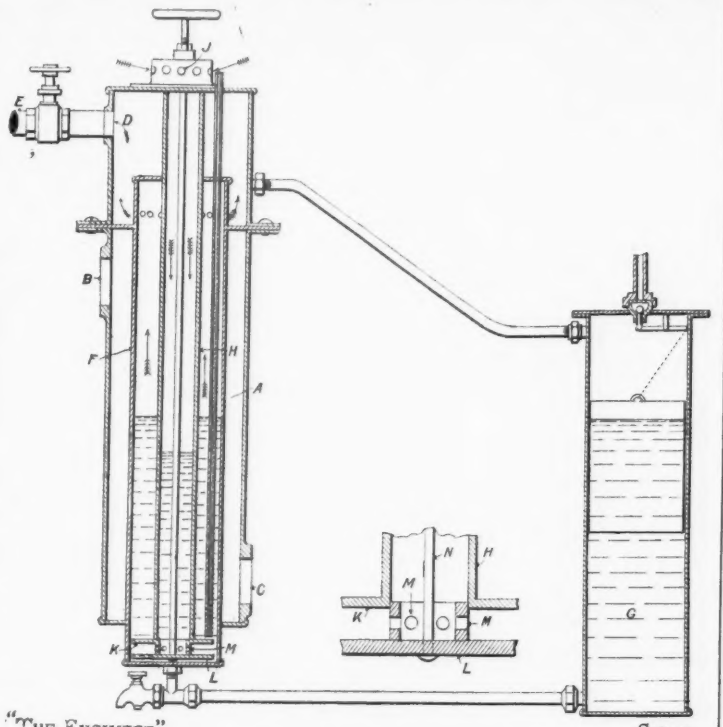


Fig. 1—DETAILS OF CARBURETTER

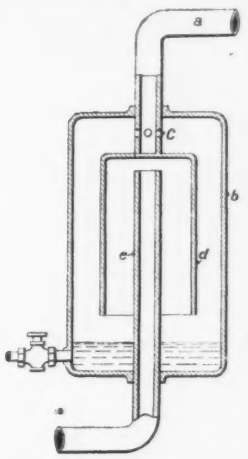


Fig. 3—OIL SEPARATOR

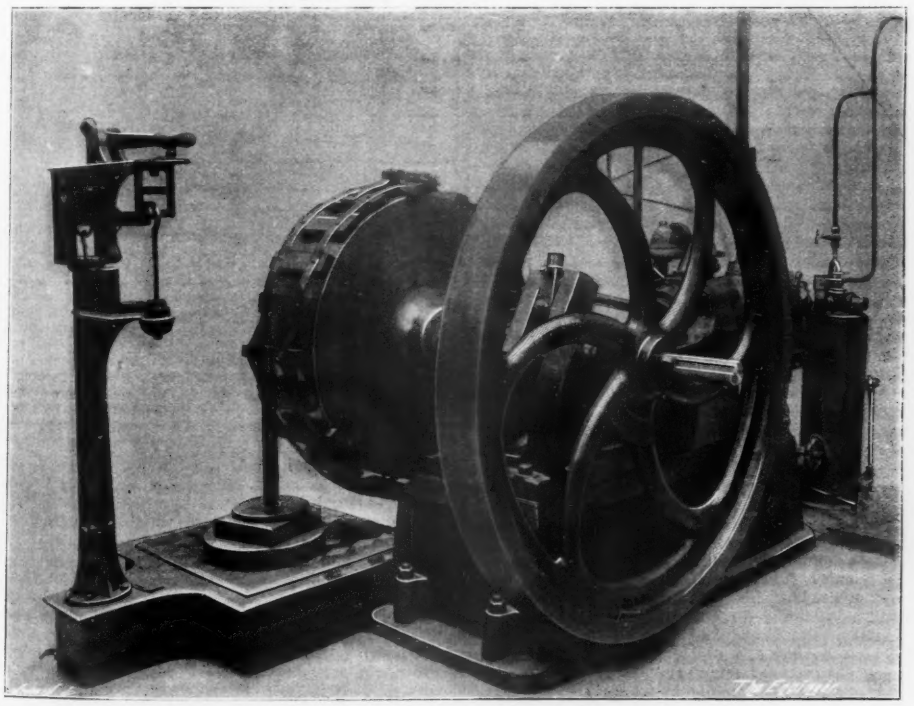


Fig. 2—ENGINE WITH CARBURETTER ATTACHED

ALUMINIUM IN THE ELECTRICAL INDUSTRIES.

IN the course of a paper on the subject of "Aluminium and its Uses," read before the Glasgow Section of the Institution of Electrical Engineers on the 10th inst., Mr. W. Murray Morrison, engineer and manager of the British Aluminium Company's Works at Foyers, N.B., declared that the production of aluminium in the present year amounted to about five thousand tons, or 100 times as much as Roscoe, thirteen years ago, in addressing the Royal Institution on the capacity of the Oldbury Aluminium Works, looked upon as a phenomenal production. Lately, owing to the high price of copper and the decreased price of aluminium, the use of the latter as a bare wire conductor had received a good deal of attention. At Foyers they had many tons of aluminium wire, cables, and strip in use, and had designed various joints for use in connection with them. They had a telephone line running a distance of six miles over exposed country, supported on poles about fifty yards apart. The joints in this line had given no trouble, but the wire in the most exposed positions had broken several times during very high winds. The wire being of a pure aluminium and being of so small a diameter accounted for this, and there was no doubt that for telephone or telegraph lines of small diameter it was necessary to use an alloy. Comprehensive experiments with the view to finding a suitable alloy had been, and were being, carried out; lines being also under trial at the present moment by the Post-office authorities and others. It was believed that solutions of the problem had been arrived at, and no doubt aluminium wire for those purposes would be ultimately as successful as copper ones, the success of which, it must be recollected, also entailed endless difficulties and failures in the early days. For connections, flexible and strip, between dynamos and furnaces a large number of tons of aluminium were in use with the most satisfactory results. This was a case in which, even were no actual saving in the first cost secured, it would still be preferable to use aluminium in place of copper, for the saving in labour of handling was most important. In America much more had been done than in this country in the way of utilising aluminium wire, and that the experience of American engineers was satisfactory was proved by the fact that aluminium had been used, or was specified, for all the later large transmission schemes. When first asked to put down aluminium instead of copper, he felt great misgivings, having the usual prejudices in favour of the latter, but after nearly six years' practical experience of the handling and use of aluminium wires, his opinion was entirely altered, and he was fully convinced of the advantage to be gained by their use; provided always that the first cost compares favourably—due consideration being also given to the reduced weight—with that of copper for the same conductivity. With regard to insulated cables in low-tension work, aluminium could not compete with copper at present prices, unless the cost of dielectrics fell very considerably, as in such cases the radial depth of insulation was determined almost entirely by considerations of mechanical strength, durability, and Board of Trade regulations. Should the price of copper increase, or that of aluminium diminish, as it seemed quite likely to do with a more extended use, then there would no doubt be competition. The case of high-tension cables was, however, on a different footing, and was a matter of extreme importance, in view of the many power Bills which had recently passed through Parliament.

THE RAILWAY CLUB.—On Thursday, November 28th, the members of the London Centre paid a visit to the Westinghouse Brake Company, York-road, King's Cross. A most enjoyable and instructive time was spent in the works, which are large and well equipped with up-to-date machinery. The whole of the shops and storehouses were visited, and amongst other things a complete installation of brake apparatus for a 50-wagon train was seen in work, and also a sectional model showing in detail the construction of the triple valve, pump, &c. On Wednesday, December 4th, the monthly meeting was held at the Memorial Hall, Farringdon-street, the chair being taken by Mr. H. W. Bardsley. The evening was devoted to railway history, and papers by Mr. C. E. Stretton, of Leicester, dealing with the London and Birmingham and Grand Junction railways, were read.

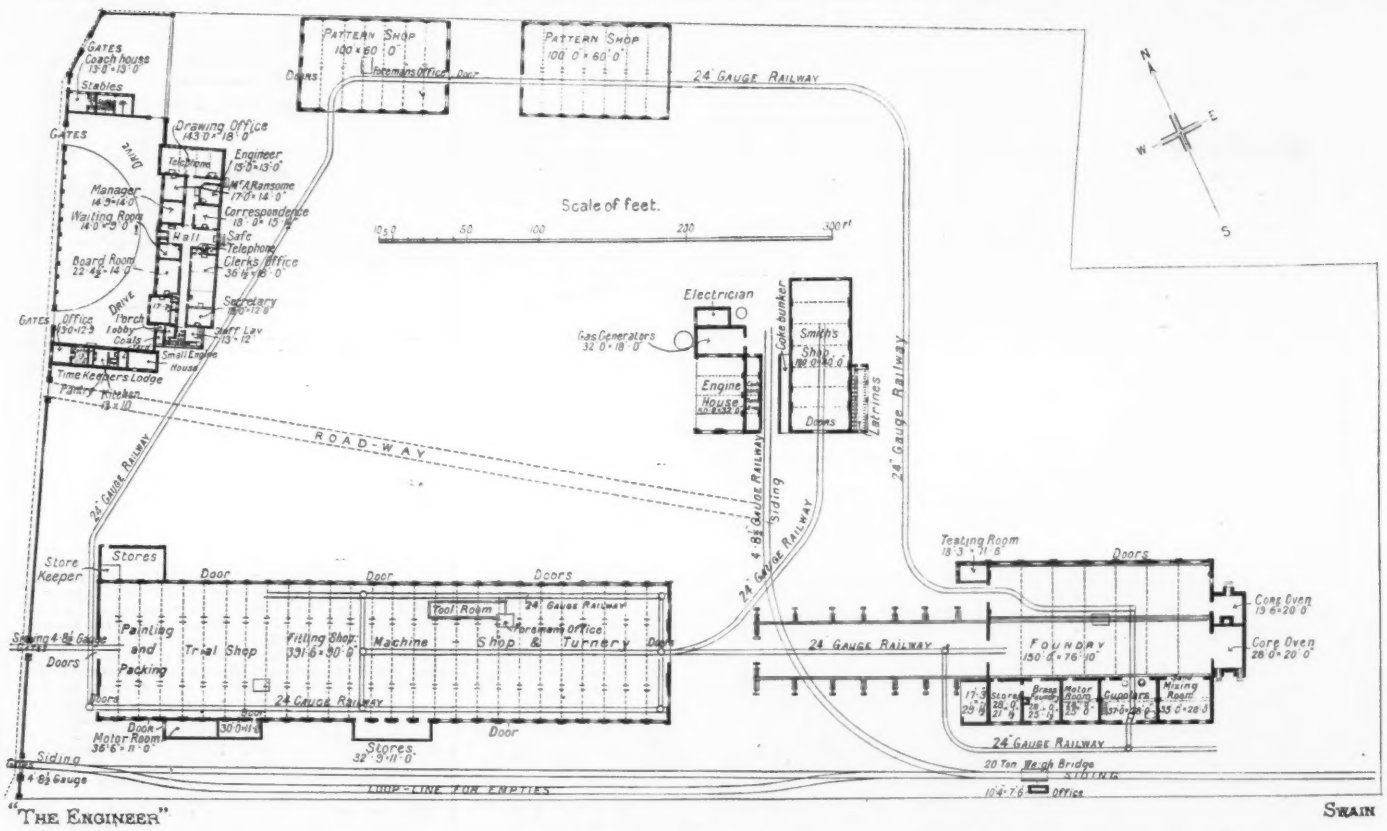
STANLEY WORKS, NEWARK-ON-TRENT.

IT is no news to our readers that many engineering firms have within recent years found it necessary to remove their works from crowded towns into what is, comparatively, the country. A long list might be given of those that have done so. In the present article we purpose describing the new works which have been erected by Messrs. A. Ransome and Co., Limited—formerly of Chelsea—at Newark-on-Trent. As will be seen from the accompanying plan, the works are erected on a nearly rectangular piece of land, one corner of the rectangle being missing. The total area of the site is some ten acres. It is but a few hundred yards from the Newark Station of the Great Northern Railway, two sidings from which run into the works—one for incoming raw material and the other for outgoing finished goods. These sidings are both of the standard gauge—4ft. 8½in.—and the inwards siding runs the whole length of the site, and has a branch siding serving the power-house and smith's shop. There is, moreover, a loop line for empties. The other siding enters the packing and painting end of the main shop, and here there is accommodation for two 10-ton wagons to stand within the building at one time. In addition to these sidings there is a complete system of smaller lines—24in. gauge—running throughout the works, and to this we shall draw more particular attention later on.

It will perhaps be best, in describing the works, to begin at the offices—the brain, as it were, of the whole—and follow the manufacture through all the different processes as it is transferred from shop to shop. To begin with, then the offices are well worthy of attention. All the various departments are arranged on one floor, and the engineering, or constructive side, is kept distinct from the purely commercial part of the business. They are placed one on either side of a central hall. This hall opens on one side to an approach drive, and on the other into the works. A dividing passage runs at right angles to this hall, and on one side of this passage are the rooms belonging to the management, the board room, &c.; and on the other are the secretary's and designer's rooms, the correspondence and the clerk's offices. The rooms are particularly well lighted, large and lofty. The floor above is used for the storing of documents, letters, books, &c., but contains no business room. Adjoining the engineering side of the offices, and only a step or two from the designer's room, is the drawing-office. Particular attention has been devoted to the lighting of this both by night and by day, with the result that the illumination is excellent. Its main windows have a nearly northerly aspect, and there are eleven windows in a length of 43ft.; they reach from desk level to the ceiling. By night this office is lighted with two inverted arc lamps, assisted by means of six adjustable pendant incandescent lights.

Each drawing has a double number, representing the particular drawer in which it is kept, and the year in which it was made. Only three sizes of drawings are employed, these being 24in. by 18in., 18in. by 12in., and 12in. by 9in. across to the border lines. The office copy is generally a cloth tracing. Space will not permit us to go deeply into the method employed for keeping the drawings, but suffice it to say that, by reason of a card index, they are all immediately accessible. Blue prints only, in special holders, are sent into the shops. Each special figure on each drawing has lines round it, and when the job is over these figures are cut out, and the various types kept together for easy reference when anything of the kind is wanted again. The blue prints are all made by electric light. Each department is provided with a pad of order forms, so that it may at any time requisition any drawing which is then booked to it. The foreman of the department then books the drawing to the men working on it.

From the drawing-office the natural step is to the pattern shop, and it will be found close at hand. It is, in fact, as will be seen from the plan, within a few yards, and every effort is made to keep the two departments in close touch with one another. This shop is a brick building, 100ft. long by 60ft. wide. It is divided into two bays by a central line of six H section joists, which support a light roof composed of corrugated iron and glass. In this building the whole of the wood working necessary for the entire business is carried out, in addition to the pattern making proper. For instance, all the packing cases are made there. This at first sight would appear to be the wrong place to do this work, which would have more appropriately been performed at the point of despatch. There are excellent reasons, however, why the company decided to keep all its wood working in one building, perhaps the chief of these being that by doing so they reduced the fire insurance premium, and kept all inflammables in one place. The machine tools employed here are nearly all of the company's own make. The shop shafting is driven by two 12 horse-power electric motors placed beneath the floor. One is used to drive a collection of special machines arranged at one end of the shop, and used for exhibition purposes. The other drives all the working tools, with the exception of the lathes, which run off countershafting on the floor, which in its turn is driven by a belt from a 2 horse-power motor carried on brackets on the wall. It is a nice light shop during the day, by reason of the number of windows and skylights, while by night it is illuminated with six arc lamps. The foreman's office is placed nearly in the centre of the shop, and is provided with windows all the way round, so that the foreman can see what is going on in all directions.


Pattern Shop 100 × 60 · 0"
Pattern Shop 100 · 0 × 60 · 0"
24" Gauge Railway
Scale of feet.
Drawing Office 43 · 0 × 18 · 0
Engineer 15 · 0 × 13 · 0
Manager 14 · 3 × 14 · 0
Waiting Room 14 · 0 × 9 · 0
Board Room 22 · 4½ × 14 · 0
Correspondence 18 · 0 × 15 · 0
Clerks' Office 36 · 6 × 18 · 0
Secretary 13 · 0 × 12 · 0
Hall
Safe
Telephone
Porch
Lobby
Coats
Staff Lav
Small Engine House
Time Keepers' Lodge
Pantry
Kitchen
Office 15 · 0 × 12 · 3
Gates
Drive
Road-way
Electrician
Gas Generators 32 · 0 × 18 · 0
Coke bunker
Smith's Shop
Engine House
Doors
Latrines
Stores
Store Keeper
Door
Painting and Packing
Trial Shop
Fitting Shop 391 · 6 × 30 · 0
Machine Shop & Turnery
Tool Room
Foreman's Office
Motor Room 36 · 6 × 11 · 0
Stores 32 · 9 × 11 · 0
Siding 4 ft 8½ Gauge
Loop-line for empties
Testing Room 18 · 3 × 11 · 6
Core Oven 19 · 6 × 20 · 0
Core Oven 28 · 0 × 20 · 0
Foundry 150 · 0 × 76 · 10
Stores 28 · 0 × 21 · 9
Brass Foundry 25 · 0 × 25 · 0
Motor Room 25 · 0 × 25 · 0
Cupolas 37 · 0 × 20 · 6
Core Mixing Room 35 · 0 × 28 · 0
20 Ton Weigh Bridge
Office
N
S
E
W

"THE ENGINEER" SWAIN

GENERAL PLAN OF WORKS

Passing from the pattern shop, the next building met with is the pattern store. It is precisely similar in size and construction to the pattern shop, being 100ft. long by 60ft. wide. There is an excellent system of storing the patterns. Each separate pattern is numbered, and is put on a numbered shelf, in a numbered tier, in a numbered rack. The record of the numbers is kept in a book in the drawing-office. There is, therefore, never at any time a difficulty in finding any one pattern.

The foundry next claims our attention. This is a building 150ft. long by 76ft. 10in. wide. It is divided into two bays, and is of precisely similar construction to the pattern shop already described. It is well illuminated both by day and night, there being twelve arc lamps—eight ordinary and four with enclosed arcs—in various parts of the premises. There are two three-motor electric cranes, one in each bay. One of these is constructed for a lift of six tons, the other for fifteen tons. This latter can travel out on a gantry, which, as will be seen from reference to the plan, stretches from the foundry nearly all the way to the machine shop. A line of tramway runs under the whole length of the gantry, and into both foundry and machine shop, and it is a simple matter to run trucks out from the machine shop under the gantry, so as to receive the castings from the foundry. And while on the subject of trucks, we may mention that those employed throughout the works are all fitted with ball bearings, and with them very considerable weights can be moved about with the greatest ease.

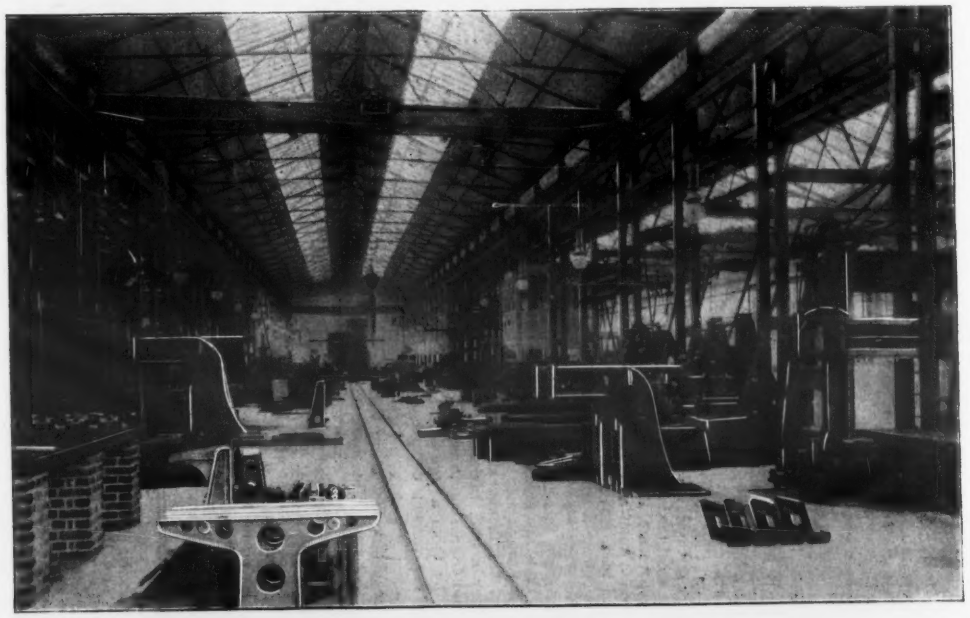
Returning to the description of the foundry, there are at one end two core ovens—one 19ft. 6in. by 20ft., the other 28ft. by 20ft. Along one side are various compartments. The first of these is for sand mixing, &c. Here there are a rocking sieve, a grinding mill, and a coal dust grinder, all worked by a motor driven shaft. The next compartment contains the cupolas, of which there are two—one of five, the other of three tons capacity. The charging floor is reached by an electric lift, the motor being of 7½ horse-power, running at 1400 revolutions per minute. On the charging floor there is ample space for the storage of coke, pig, and limestone; and on the same level, but over the sand-mixing compartment, there is a large room for the storage of sand, with shoots leading down to the lower level. One of the railway sidings already mentioned runs along beside the foundry, and there is a 20-ton weighbridge, so that all the material can be weighed as it is delivered. Over this weighbridge every railway wagon delivering material to either the foundry, smith's shop, or power-house must pass. In the next compartment to the cupolas is the blowing apparatus, consisting of a Sturtevant centrifugal fan driven by a motor of about 34 horse-power. In this room it is intended to erect shortly an air-compressing plant for the working of pneumatic tools. A small brass foundry occupies the next compartment. In this there are two crucible furnaces with a jib crane fixed above them, and all the necessary appurtenances for making brass castings. Next comes a metal store, and next a compartment partially open to the air, which is at present used as a joiners' shop and pattern store. On the other side of the building there is a small compartment where breaking tests, &c., are carried out in connection with the metal used, and in this room there is a little motor, which turns a shaft going through into the foundry. This works the emery wheels for fettling, and a fan for the core oven fires. The various boxes used for the mould are stacked underneath the gantry.

Passing on round the works we come to the machine shop, which is a building 391ft. 6in. long by 90ft. wide. Here again we see the same construction—brick walls with corrugated iron and glass for roofing. Here also the same attention has been paid to illumination, which is a subject on the importance of which we have so often dwelt in these columns. There are three bays running the whole length of the shop. The roof supports—which are placed at about 14ft. 6in. centres—are two H section joists placed side by side, braced together some 10ft. from the floor by two further H joists, which are used for carrying the pulleys and countershafts for the various machines. This main shafting is divided into four separate portions, two on each side of the shop. Each section of shafting is 100ft. long, and can be separately driven by a 20 horse-power motor running at 500 revolutions per minute. The two lengths of shafting on each side of the shop can, however, be coupled together so as to form a length of 200ft., with two 20 horse-power motors driving it. These motors are each contained in a pit beneath the floor and drive up to the shafting, carried on the roof uprights, by means of belts. The whole of the shafting runs in roller bearings, and we are informed that these have given the most marked satisfaction, and have amply justified the original expenditure upon them. The only other motor for driving tools is of 2 horse-power. It is fixed on cross girders, and is connected to a grindstone and a drilling machine. There are two overhead cranes in the centre or main bay. One of these is of Vaughan's make, is for a lift of 10 tons, and is worked by three motors. The other is for lighter loads and has only one motor. In addition to these there are four jib cranes, three of them being over lathes

STANLEY WORKS, NEWARK-ON-TRENT

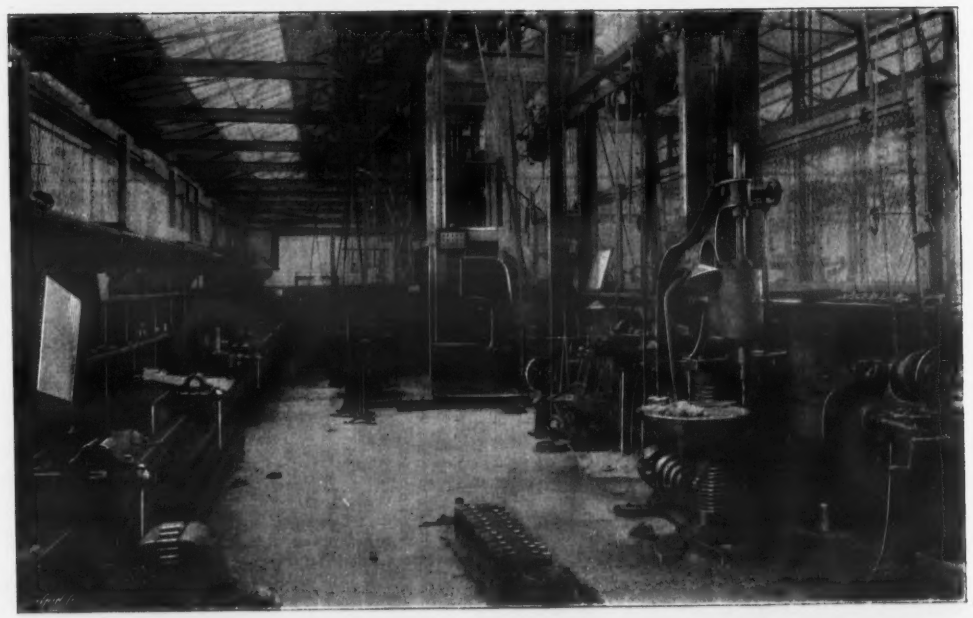
A. RANSOME AND CO., LIMITED, ENGINEERS

(*For description see page* 626)



VIEW DOWN MAIN SHOP

MACHINE SHOP



TOOL ROOM

FITTING AND ERECTING SHOP

and the fourth over a drilling machine. There are also on cross joists which connect the main roof supports with the side walls—or, in other words, bridge the two side bays—a number of travelling monkeys, to which can be attached differential blocks or other means of lifting weights by hand power.

The general arrangement of the shop is excellent. The machines are all placed in the order in which they are most generally used. The work enters the shop from the foundry end, either from the foundry or from the smiths' shop, and travels round from machine to machine until it is completed. The tools have been well chosen, and grouped in the most advantageous manner. A noticeable feature is the amount of room available. This—provided, of course, that the price or the rent of ground do not make it prohibitive—is an important factor in economical production, for it allows, among other things, of a simple and systematic stacking and checking of the various portions of a machine undergoing construction. We shall have occasion to refer to this feature a little later on.

The whole shop, though it consists of one continuous building, is in reality divided into four distinct divisions. These are the machine shop, the fitting shop, the testing shop, and the painting and packing shop, and the work being made gradually travels from one end to the other, and is finally despatched in the railway wagons already mentioned as coming into this building on the siding. A great deal of attention is paid to testing, and for this purpose special arrangements have been made. A brick-lined pit of large dimensions has been formed in the centre of the main bay, so that big machines which have a considerable part of their structure beneath the ground line can be tested under conditions precisely similar to those which will be met in ordinary working. For the purpose of driving these machines a shaft runs right across the building, at right angles to its length, and in a trench under the floor level. This shaft is worked from a motor in a small outbuilding attached to the main shop. The motor is of 20 horse-power, and series wound, arrangements being made by which its speed of running can be varied at will over a considerable range of velocities, so that there shall not be the necessity of changing the pulleys on the main driving shaft when machines with very varying sizes of pulleys are being tested. The same driving shaft can also be used for giving power to a complete set of cask-making machinery which—as will be seen from one of the photographs which we reproduce—has been collected in this shop.

The method by which the tools necessary for working are distributed to the men is worthy of special notice as being one of the best, if not quite the best, at present existing. There is an excellent tool room—a photograph of which we reproduce—and it contains all the requisite apparatus and machines for producing all the tools required in the works. These tools are all standardised and numbered. Blue-prints showing the forms of these tools and their numbers are hung in many parts of the shop and in the tool room. Electric bell pushes connected through an indicator to a bell in the tool room are fastened to the uprights supporting the roof, and these pushes are within easy reach of the workmen at the machines. If a tool is required the man wanting it presses a push. The indicator shows in what part of the building a tool is wanted, and a boy—several of whom are employed solely for this purpose—is sent running off to see what is required. He is told a number and runs back to the room to get the corresponding tool, which is booked to the man to whom it is delivered. In this way no workman ever goes to the tool room, for, as Messrs. Ransome say, the wages of a boy are much less than those of a workman. Arc lamps are generally employed for the illumination of this shop by night, but a certain number of incandescent lamps are supplied for machines where special illumination is required, and for the fitters' benches, which are placed along the wall. There are stores for bolts, pins, oil, waste, collars, handles, and scrap metal, and also for various other finished articles used during manufacture; and there is also a general shop store placed near the despatching end, the store-keeper being responsible for the entering of outgoing goods.

There still remain to be described the smiths' shop and the power-house. We reproduce a photograph of the former. It is a building of the same general construction as all the others. It is 100ft. long by 40ft. wide. There are ten hearths at present in place down one side, and one on the other side, in addition to a small heating furnace. The remainder of this side is at present utilised for the stacking of bars, &c. The fan fires are worked by means of a motor-driven blower, the motor being bolted to the wall of the building, and the blower being placed beneath the floor. There is also a motor-driven exhaust fan for withdrawing the fumes and smoke from the fires, over each of which is a funnel-shaped cowl connected to a general exhaust pipe. There is also a small steam hammer, made by B. and S. Massey, and a grindstone separately worked by a small motor. Adjoining this building are the urinals and closets for the men, and though, perhaps, this is not properly an engineering matter, yet, as works' owners know only too well, a great deal depends upon the management of this portion of the premises. Here a trustworthy man is put in charge, whose duty it is not only to keep the place clean, but to book each man's time in and out. We are informed that great benefit has resulted from this system.

In the power-house, which is close to the smiths' shop, there has been a wide departure from general practice, inasmuch as gas engines are employed instead of steam, and the gas is manufactured on the site. The building is similar to all the others, but one side of it is simply covered in with corrugated iron, so as to allow of ready extension. The main driving plant consists of two single-cylinder horizontal Stockport gas engines, which each drive, by means of eight 1¼in. cotton ropes, a Lawrence Scott four-pole compound-wound dynamo, giving 315 ampères at 205 volts. The horse-power of the engines is nominally 100, but each is frequently worked up to 120 horse-power. The engines run at about 205 revolutions, and the dynamos at about 500. The whole plant has, so we understand, given every satisfaction. The switchboard was made by James White, of Glasgow, and it has mounted on it Kelvin instruments for showing the current which is going to various shops, voltmeters, minimum cut-outs, &c. The dynamos have three bearings, one of them outside the rope driving pulley, and there is a ratchet-worked arrangement to move the dynamos, so as to take up the slack in the ropes. A small travelling crane spans the shop. The engines exhaust into silencers. The gas-producing plant adjoins the engine-room. There are two Paisley and Welsh producers, with the necessary coolers, scrubbers, gasholders, &c., and an upright boiler, by Nicholson, which works at 60 lb., and also supplies steam for the hammer in the smiths' shop. There is a large tank running alongside the engine-room and carried on brick uprights. This is for the engine cylinder cooling water and for the boiler feed. Underneath it is a coal store, which will hold some 50 tons, the railway siding coming right up to it. There is also another tank filled from a well by a small electrically-driven centrifugal pump, which is automatically governed by the depth of water in the tank. This water is used for cooling and scrubbing the gas and for the urinals. It is not suitable for either the boiler or for the cooling jackets of the engines.

This completes the general description of these interesting works, and we think that with the aid of the accompanying engravings and plan our readers will be able to form an excellent conception as to their scope. There are certain details in working, however, which it will doubtless prove interesting to mention. It will be observed from the plan that a system of tramways runs all over the works and through all the shops. This, in conjunction with the ball-bearing trolleys already alluded to, is of immense use. From personal experience we can say that it requires but a small effort to move a very heavy weight on these trucks. The moving about of weights has been rendered easier by the fact that the site, which was, before being built on, much on the slope, has had a great deal of levelling done to it. Were it not for these tramways, it is not too much to say that it would be impossible to carry on economically the works as constructed.

We have, perhaps, said enough to show how that a set cycle of operations is carried out in these works. The material progresses through the various stages from the crude metal to the rough and then the finished article, without being taken a step backwards. Then there is the system of collecting the various portions of a machine for inspection, &c., which we have alluded to, and will now proceed to discuss at greater length. The machine shop floor is of concrete, and is divided conveniently into squares. Each of these squares is allotted to a certain job, and on to it as soon as each piece is completed it is taken. If there are several pieces of the same form these are placed neatly together. On the square is also a table with an upper and lower shelf, and on this the smaller iron and steel work and the gun-metal and brass portions are arranged. The table also has upon it a type-written list of all the various parts and the numbers of these required for the order. It is, hence, a very simple matter for the works' manager or his assistant to see exactly at any time in what condition any of the work stands. There is also a system of marking every single piece of metal with its order number as soon as ever it comes into the machine shop—with chalk first when it is in the rough, and later on with metal punches. This facilitates their arrangement on the floor spaces, and also the making out by the men of their time sheets. Of course, this sort of system is only possible when there is plenty of space, but it is so well worth doing, that probably when the time comes for extension Messrs. Ransomes will be wise in building further shops rather than in putting new machines on the floor space now so usefully employed. Another saving of money is in the employment of time-recorders and the doing away with time-keepers of every kind. There are Rochester time-recorders in every shop. Each man as he comes in inserts his own particular card in a slot and presses a knob. His times in and times out for a whole week are recorded on one card, and by this card—and by nothing else—he is paid. His own interest, therefore, compels him to be careful in seeing that his record is made properly. A great saving of time is also effected by having a complete system of telephones all over the whole works and offices. Many a walk backwards and forwards from shop to shop, and from shop to offices, is thereby avoided. Moreover, by them a great advantage is obtained in keeping the various departments in touch.

Space will not permit of our dilating further on these excellent works, but we think that enough has been said to show that they have been designed and constructed on the very best modern lines, and that they are managed with skill and ability. We have to thank A. Ransome and Co. for the facilities they afforded us for examining every detail of their works on the occasion of our visit, and for the pains they took in giving us all the information for which we asked. The engravings referred to in the foregoing article will be found on pages 627 and 630.

ON Thursday, December 12th, a meeting of the Glasgow University Engineering Society was held, Arch. Denny, Esq., M.I.N.A., M.I.C.E., occupying the chair. A paper was read by James Rowan, Esq., M.I.C.E., on "Workshop Management." Mr. Rowan treated his subject with special reference to his own works, which the members visited the preceding Saturday. A long and interesting discussion followed. The annual dinner was held on Friday. On Saturday, December 14th, a visit was paid to the North Johnstone and Dalby Railway. Taking train to Beith, the party was conducted along the line, and saw the different operations which were being carried on.

LEEDS ASSOCIATION OF ENGINEERS.

THE FUTURE OF ELECTRICITY.

THE Leeds Association of Engineers held its thirty-sixth annual dinner at the Queen's Hotel on Saturday evening, December 7th. There was a large attendance. The chair was occupied by Mr. J. H. Wicksteed, who, in proposing the toast of "Prosperity to the Association," remarked that English people seemed to be able to do big things better than they seemed to do little things. There was no doubt that the important engineering inventions had been made in England—Bessemer steel, Siemens steel, basic steel, and many other things. Referring to the American automatic gear cutter, he said the Americans did not invent it. More than twenty years ago he had seen at Messrs. Lawson's, in Leeds, these automatic gear cutters cutting wheels as if they were used to it, with one attendant to wait upon them.

The English-made invention was all right, but he thought there had been a certain contempt for refinement, and aversion to being disturbed and coerced into "going one better." There had been a want of ambition to break the previous record, which had prevented a useful amount of attention being paid to the perfecting of details, and the saving in small ways of every bit of trouble that could be saved. He thought the workman should leave off priding himself exclusively upon his handicraft, and become to some extent the master and director of mechanism that would save him the skill of hand. If the foreman could find a stimulus to more initiative in the direction of keeping every detail up to its full working possibilities, he thought that there was in this nation sufficient talent lying latent, a hundred times over, to enable them to keep the mechanical ascendency of the whole world. They must take in the idea that there was no finality, and if they wanted to keep ahead they must be always improving.

The President (Mr. G. W. Blackburn) acknowledged the toast. He remarked that the Association was never more prosperous than at the present time, both as to the number of members and financially.

Alderman Wurtzburg proposed "The City and Trade of Leeds." He said that recently they could congratulate themselves upon brilliant trade in the iron industry, but there were now signs of depression. They had heard a great deal of German competition, and it had not altogether been a fair competition. He had known cases where the Germans gave credit for one, two, and three years, which was really absurd. They would see what the Germans had done in electrical work, taking a contract £35,000 below the lowest English tender, for Manchester. He thought they need not much regret that contract having gone to Germany, because he was sure, at the price they had taken it, they would not make much by it. Although their prospects were not bright at present, they had no reason to be discouraged, and might look with confidence to the future. Let them take such hints from the Germans and Americans as would help them in their trade development, but let them not copy those things which were wrong and false.

INTERNAL COMBUSTION ENGINES FOR MOTOR CARS.

At the monthly meeting of this Association, the president, Mr. Geo. W. Blackburn, M.I.M.E., in the chair, Mr. F. G. Heseldin gave a paper on "Internal Combustion Engines for Motor Cars." Since 1895, he said, when M. Panhard startled the world by his famous ride from Paris to Bordeaux, 744 miles, at an average speed of 15 miles an hour, the internal combustion spirit motor has proved itself without a rival for the propulsion of vehicles over long distances at high speeds. In the recent Paris-Berlin race, the highest speed averaged 44 miles per hour over the total distance—775 miles—and the weight of the propelling machinery was only 10 lb. per brake horse-power. Having no restrictions, the French had been able to build up an enormous industry in the manufacture, some firms employing 2500 hands and turning out ninety cars per month, valued at £65,000. The chief features of the De Dion, Panhard, Daimler, Mors, Hautier, Korte, Gobron-Brillé, Benz, Peugeot, and Wolseley engines were described in detail, including the methods of carburation of the spirit, the arrangements for exploding the charge, the balancing of moving parts, and the attempts at governing and the silencing of the exhaust. It was pointed out that the size of the wearing surfaces in most cases was quite inadequate, resulting in frequent breakdowns and rapid wear, and would not be tolerated in the design of a steam engine running at the high speed of these motors, viz., from 750 to 2000 revolutions per minute.

The following formula, deduced from experiments, gave the power of this class of engine:—

$$\text{B.H.P.} = \frac{D^2 \times (L + C) \times \left[\frac{(L + C)^{\frac{1}{3}}}{C} - 1\right] \times N}{12{,}000}$$

D = diameter of cylinder in inches.
L = stroke of cylinder in inches.
C = clearance volume divided by area of piston in square inches.
N = revolutions per minute.

The speed of gases through valves was about—
Inlet, automatic = 60ft. per second.
Inlet, mechanically operated = 90ft. per second.
Exhaust, 75ft. per second.

Improvements, Mr. Heseldin said, might be expected to consist in better balancing, the increasing to a very considerable extent of the wearing surfaces, and the complete substitution of electrical for tube ignition, thereby preventing the liability of the motor catching fire. It was, he said, to be regretted that the industry in this country had been taken up chiefly by cycle firms, who did not possess the requisite plant and experience, and also suffered by the abuses of company promotion, and the wholesale buying of worthless patents. It was gratifying, however, to find that expert engineers had now taken the matter up, and the awards at the recent Reliability trials at Glasgow showed that cars were being produced in this country equal or even superior to those of our continental rivals.

In the discussion which followed several speakers pointed out that, when a motor car was purchased, the fact was often overlooked that an intelligent appreciation of its working parts, together with due attention, was essential to obtain satisfactory results.

THE JAMES BREMNER MEMORIAL.—On inquiry we are informed by one of the honorary treasurers that the amount already subscribed towards the James Bremner memorial fund now stands at £136, or at less than one-half the sum originally aimed at, as the cost of erecting a statue to James Bremner, who, in 1846, "removed Great Britain from Ireland," as the common joke of the day expressed it, when that eminent Caithness engineer raised the sister ship of the Great Eastern, after she had run aground in Dundrum Bay and every effort and every appliance until then known in engineering had hopelessly failed. During his long and useful life "Jim" Bremner raised 236 vessels, some of them from a depth of eleven fathoms, and after they had been lying at the bottom of the sea for periods as long as two years. He was, moreover, the builder of a large number of harbours on the shores of northern Scotland. It was proposed by the Town Councils of Wick and Pulteney Town some time ago to erect a statue in his honour, but subscriptions have of late only been coming in at rather long intervals. The promoters will be grateful to receive further help from his professional brethren and others towards the accomplishment of their project. Mr. Hector Sutherland, town clerk of Wick, N.B., and Mr. A. O. Green, town clerk of Pulteney Town, N.B., are the honorary treasurers to the memorial fund.

RAILWAY MATTERS.

THE maximum speed authorised by Belgian State lines express trains is 100 kilometres—62·1 miles—per hour.

THE number of cars running in each direction on the Boston shallow underground tramways is about 250 per hour, or about 4000 in each direction per day of sixteen hours.

LAST Saturday Sir William Macgregor, Governor of Lagos, opened the branch railway from Aro to Abeokuta. The ceremony was performed in the presence of the Alake and his Council.

THE retirement of Mr. Benjamin Shaw, goods manager of the Lancashire and Yorkshire Railway Company, takes place this month, after forty-eight years' service in various capacities. The directors have appointed Mr. Wharton, of Heckmondwike, to succeed him.

IN some past years as many as 100 engines have been built in Leeds for India, and this year's work will not fall far short of that number. In the three years of the great famine of 1883, 1884, and 1885, the number of locomotives built in this country and sent out to India was a little over 400.

ON Sunday last an express and a freight train ran into each other from opposite directions near Perryville, on the Illinois Central Railroad. Ten persons lost their lives. An oil tank in the freight train exploded, throwing burning oil over the wreck, and the bodies of the victims were reduced to ashes.

IN connection with the Fishguard and Rosslare route to Ireland, a contract for the erection of a pier 1000ft. long at Rosslare has been closed. This pier is a portion of the scheme in which the Great Western Railway of England and the Great Southern and Western of Ireland are concerned. A fast line of steamers is to run between Fishguard, on the Welsh coast, and Rosslare.

THE standard height of the roof in the Boston shallow underground tramways is 14ft. clear above the surface of the rail, and the roof is generally about 3ft. below the street surface, but in some parts the subway is lower than this. To reach the cars short staircases of from 20 to 30 steps are provided. The level of the platforms is about 1ft. above that of the rails. No provision for pipes is made.

AN interesting long-distance run is made by a fast train, "No. 99," between Paris and Bordeaux. Between Paris and Thouars, 201·9 miles, the journey is made by one and the same engine. This train is generally made up of six four-wheeled vehicles, weighing 112 tons, and a dining car weighing 28 tons, on two four-wheeled bogies. The maximum speed authorised between Paris and Thouars is 56 miles per hour.

ACCORDING to a *Times* telegram from Calcutta, the Secretary of State for India has sanctioned an expenditure of 1050 lakhs of rupees on railways for next year and of 100 lakhs on irrigation works. The former includes 325 lakhs for rolling stock, 180 lakhs for other necessary works on open lines, 350 lakhs for lines being constructed, and 174 for new lines, including the Allahabad - Faizabad line, with a new bridge over the Ganges.

THE Conference of Indian railway engineers and locomotive officers, convened at the instance of the Secretary of State, in consultation with the Viceroy, to consider the subject of the supply of locomotives to the Indian railways and the question of standardisation of British-made engines, held at Calcutta, has decided to ask British locomotive builders to submit designs for a number of engines, about sixteen in all, of varying weight and power, and suitable to the broad and narrow gauges of the Indian railways.

THE locomotive building trade of the United Kingdom has been good this year. The declared value of the locomotives exported for the eleven months ended November 30th was £1,732,921, which is more than a quarter of a million greater than the total for the completed twelve months of last year. The year's exports give fair promise of exceeding the greatest total hitherto recorded, and we have to go back to the year 1890 to find a year's total greater than the figures for the eleven months of the current year.

A DEPARTMENTAL Committee of the Board of Trade has been appointed to consider and report what additions or amendments to the Light Railways Bill, 1901, it would be desirable to propose, having regard to the provisions of the Tramways Act of 1870, and the Light Railways Act of 1896. The members of the committee are:—Sir Francis Hopwood, K.C.B., C.M.G. (chairman), Sir John E. Dorington, Bart., M.P.; Col. Sir Herbert Jekyll, K.C.M.G.; Mr. Sydney Morse, Mr. A. T. Tring, Mr. George White, and Mr. W. J. Jeeves.

THE directors of the Central London Railway have deposited a Bill for next session for converting their line into a circular railway. From the present terminus at "the Bank" it is proposed to be carried to Liverpool-street, and from there back, *viâ* Cannon-street, Ludgate-circus, Charing Cross, Piccadilly-circus, St. James's-street, Hyde Park-corner, Knightsbridge, Albert Hall, High-street, Kensington, Addison-road, Hammersmith, and round to the present West End terminus at Shepherd's Bush. In this way the trains will be run continuously without shunting or changing engines, as at present.

THE report of the New South Wales Railway Commissioners for the quarter ended September 30th last states that the number of miles of tramways open has increased from 76¾ to 80, the revenue has gone up from £116,000 to £136,049, but the earnings per car mile for the quarter ended September 30th this year have fallen off from 1s. 6¼d. to 1s. 3¼d. The expenditure per car mile still remains high—1s. 1d., a decrease of 2¼d. as compared with the corresponding quarter last year. While the total expenditure has gone up from £97,125 to £117,168; the percentage of expenditure to earnings is 86·12 as compared with 83·58 in 1900. The number of passengers carried has increased by about 3½ millions.

A SUB-COMMITTEE representing the Trunk Line Association, the Central Traffic Association, and the Western Passenger Association, have unanimously recommended that the issuing of railroad passes for any purpose whatsoever be discontinued, says an American contemporary. It is the purpose of the railroad managers to cut off all free transportation. This step will involve the discontinuance of the old-time practice of exchanging annual passes between the principal officers of each railroad. No employés, politicians, legislators, or other persons will be granted free transportation—provided the associations named ratify the sub-committee's recommendation. We understand that these associations embrace most of the important railroad systems east of the Mississippi River.

THE North-Eastern Railway has for some time past been investigating the question of passenger mileage, ton mileage, and train-load results after the manner employed by the American railways. The current issue of the *Statist* contains the results of its inquiries, and is authorised by Mr. Gibb, the general manager, to announce that the company will in future regularly compile its passenger and ton mileage, train loads, and other particulars necessary for the working of railways upon modern principles of economy. The investigation made by the company shows that its average train load of merchandise and live stock is only 44·18 tons, of minerals 92·49 tons, and that its total average freight-train load is no more than 66·60 tons. The average number of passengers per train is 62·40.

NOTES AND MEMORANDA.

THE import duty on motor carriages in France is 60f. per 100 kilos., say £1 5s. per cwt.

THE Grays District Council is about to supply electric current in artisans' houses on the penny-in-the-slot principle. For a penny one-sixth of a B.T.U. will be supplied.

A COMPARISON of the number of completed English patents for coal-tar products taken during 1886-1900 by the six largest English and six largest German firms shows 86 patents for the former and 948 for the latter.

THE Franklin Institute has awarded to Professor Elihu Thomson the John Scott legacy premium and medal for his invention of the constant-current alternating arc-light transformer, known as the General Electric floating-coil type of apparatus.

DURING 1900 vessels of the gross tonnage of 600,000 were transferred from the British register to foreign owners, over 1,200,000 tons being added to the British register. While the additions, however, consisted almost entirely of new vessels constructed in the United Kingdom, the transfers were old ships.

THE exports of coal-tar colours manufactured in England have fallen from £530,000 in 1890 to £366,500 in 1899. Comparing these figures with the rapidly-increasing export trade of Germany, whereas formerly the English export trade in artificial colours was about one-quarter that of Germany, it does not now amount to a tenth part.

WE understand that the Ilford Council have just contracted with the May-Oatway Fire Appliances, Limited, to equip their new town hall with a system of May-Oatway fire-alarms. It will be the first town hall in Great Britain equipped to automatically announce its own fires direct to the fire brigade within a few seconds of an outbreak.

THE joint capital of the six largest manufacturers of coal-tar colours in Germany amounts to quite 2½ millions sterling. They employ together about 500 chemists, 350 engineers and other technologists, 1360 business managers, clerks, travellers, &c., and more than 18,000 workpeople. Compared with such figures as these the English colour manufacture assumes insignificant proportions. The total capital invested in the coal tar colour trade in England probably does not exceed £500,000.

IN view of the considerable movement towards the use of alcohol for industrial purposes, the administration of the Lille International Exhibition, 1902, has decided to organise a special section for alcohol, in which all its applications will be represented, in order to favour the use of this product, and bring to the notice of interested parties the best means of substituting its use for that of petroleum. The object is to endow France with a heating, lighting, and motive power produced from its own soil.

IN the Herœus process of welding aluminium the operation consists of cleaning the surfaces of the metal to be joined, laying them together, and heating them carefully to the temperature at which the metal commences to soften, keeping at that temperature, and meanwhile hammering together to a perfect weld. It is important that the temperature be kept constant. If it rises too high the metal becomes short or granular, and commences to oxidise, a condition which renders the weld useless.

ACCORDING to a return which has been prepared of charges for water, gas, and electricity in seventy English boroughs, the water rate of Liverpool is the lowest for domestic purposes, viz., 7½d. in the £. In Bury and Rochdale the rate is 2s. in the £, while Manchester charges 8d. The inhabitants of Widnes pay the least for gas, viz., 1s. 4d. per 1000 cubic feet, while in Norwich and King's Lynn the charge is 3s. 6d. Bristolians only pay 3¾d. per unit for electric current, and King's Lynn, 3 1/16d. per unit.

THE disadvantages inherent in the Nernst lamp so far are the deterioration of the glowers, the necessity for and deterioration of heaters, and the necessity for heater cut-outs and "ballast" resistances of special construction. The deterioration of the heater of the Nernst lamp is not due to its active service, which covers a period of less than a minute each time a lamp is lighted, but to its continued proximity to the glowers. The glowers require renewal about every 900 hours, and the heaters give out after about 2500 hours.

ACCORDING to the *Times*, the German Admiralty has under consideration a new type of small cruiser, an improvement on the vessels of the Gazelle class. These last have a length of 328ft., beam 38ft. 7in., displacement 2660 tons, speed 22 knots, and a complement of 249 men. The new type will have a length of 360ft., beam 40ft. 4in., displacement 2715 tons, speed 24 knots, and a complement of 260 men. The armament has not yet been decided upon, but it will be more powerful than that of the Gazelle type, and possess all the latest improvements.

IN a paper read before the Society of Arts last week by Professor E. Wilson, the following were given as the constituents of a good aluminium solder:—28 lb. block tin, 14 lb. phosphor tin—10 per cent. phosphorus—3·5 lb. lead, and 7 lb. spelter. The following instructions should be followed when soldering aluminium:—Clean off all dirt and grease from the surface of the metal with benzine, apply the solder with a copper bit, and when the molten solder covers the surface of the metal, scratch through the solder with a wire brush, by which means the oxide is broken and taken up. Quick manipulation is necessary.

IN a Berlin paper it is stated that a new process of manufacturing steel has been discovered. The inventor is Herr David Giebler, of Grabow, in Mecklenburg. It is alleged that his process of manufacturing gives the steel a hardness which is double that of steels made by the Krupp and Harvey processes, while the cost of making is diminished by 50 per cent. Projectiles which were shot against a 7½ mm. armour plate made by the Giebler process made an impression of only 1 mm., whilst Krupp steel armour of 11⅝ mm. was completely perforated. Blades made of the new steel are said to have shivered blades of old steel into splinters as if they were of wood.

THE control of the highways of this country is divided between no less than 1879 different authorities, whose limited jurisdictions and inadequate powers prevent the exercise of any effective control over the development of urban districts. It is claimed by the Roads Improvement Association that the work they perform could be carried out far more efficiently and far more cheaply by less than one-tenth of that number. In Lancashire alone there are no less than 151 highway authorities exercising jurisdiction over areas which have been mapped out in an arbitrary way without any regard as to what would constitute an efficient unit for the purposes of highway administration.

CLYDE shipbuilders have begun the new century by establishing a record. For the first time in the history of the industry, says the *Scotsman*, the launching output for the year exceeds the half-million tons, and the total is the more creditable because the great majority of the firms in their returns give the Board of Trade gross tonnage, whereas if allowance were made in all cases for deck erections, the figures would be considerably larger. As it is, the half million is exceeded by nearly 15,000 tons, an excess which in itself represents a fair year's work for an average yard. Returns have been received from forty-eight yards, and these show an output of 283 vessels, whose aggregate measurement is 514,975 tons. Compared with last year, there is a decrease of 35 vessels, but an increase of 22,740 tons; while the contrast with 1899, hitherto the "record" year, shows a decrease of seventy-one vessels, but an increase of 20,642 tons.

MISCELLANEA.

THE Neath Rural District Council proposes an expenditure of £163,000 for water supply.

WE are informed that H.R.H. the Prince of Wales has accepted the presidency of the Society of Arts, which was vacated by his Majesty on his accession.

A CARDIFF firm is about to start a new steamer to trade with coal from Australia to the west coast of America, and general cargo to Chinese ports. This is the Mercedes, 7000 tons, stated to be the finest collier afloat.

WE understand that the Admiralty are carrying out experiments which, it is hoped, may prevent leaky tubes in Belleville boilers. It is said that a satisfactory remedy has been discovered. The joints of the tubes are being packed with a special form of asbestos, which prevents all leakage.

ON Wednesday the premises of Gent and Co., electrical engineers, Leicester, were destroyed by fire. The flames broke out in the insulated wire factory, and spread rapidly, despite all the efforts of the brigade, until the whole building was gutted. The origin of the fire is unknown. The damage is estimated at £15,000.

THE President of the United States has definitely decided not to accept Mr. Carnegie's offer of £2,000,000 in Steel Trust bonds for public educational purposes. The provision attached to the offer, to the effect that the Government should hold the bonds for a term of years, is regarded as being especially objectionable.

THE cruiser Minerva was taken into Keyham Dock, Devonport, on Tuesday, for trials in the basin without her propellers. The experiments are being carried out under the direction of the Boilers Committee in conection with the series of tests of the efficiency of the Belleville boilers. The cruiser Hyacinth will also have her propellers removed in order that she may undergo similar trials.

THE inhabitants of Jerusalem are now provided with a sufficient supply of spring water for drinking purposes. The new works commenced in July were opened at the end of last month. The supply is derived from three tributary springs in the neighbourhood of the Pools of Solomon, to the south-west of Bethlehem, and distant about three hours from Jerusalem. During the dry season about 90,000 gallons of water per twenty-four hours is obtained from this source.

THE Government of Natal has just placed the order for one of Clark and Standfield's floating graving docks with the firm of C. S. Swan and Hunter, Limited, to be delivered by them at the port of Durban at the end of next year. The order was placed on the 16th of this month, and it has to leave the Tyne by August 31st next year. The lifting power of this dock is 4500 tons, and its length 325ft. This makes the fifth Government dock at present under construction from the plans of Clark and Standfield.

THE *Moniteur Belge* of the 2nd inst. announces that tenders will be received not later than January 28th, 1902, for the work of improving the Ghent Canal at Terneuzen, between the bridge at Wondelgem and the Canardière Bridge below Langerbrugge. The upset price of the work is £145,462 5s. 2d., and a deposit of £7200 is required. The chief engineer is M. de Heem, Directeur des Ponts et Chaussées, Rue d'Abraham No. 11, Gand, and the engineer-in-charge, M. Grenier, Quai des Tonneliers No. 6, Gand (Ghent).

THE experiments with liquid fuel in the cruiser Arrogant, now refitting at Devonport, are likely to commence earlier than was at first intended. The original intention was to make the necessary alterations in her stokehold after the next cruise of the Channel squadron, but there is now reason to believe that this will be done forthwith, says the *Western Morning News*. The liquid fuel installation is to be applied to the six boilers in the after boiler-room only, and the tanks for the storage of the liquid fuel are already in course of manufacture.

THE anomalous state of the laws governing the use of "light locomotives" under the 1896 Act was well illustrated the other day in connection with the War-office trials at Aldershot, when the driver of the Straker steam lorry was fined £5 for travelling at a speed of six miles per hour through the village of Weston, although a higher speed than this was required by Government officials, namely, the War-office Committee on Mechanical Transport. Presumably the vehicle was classed as a traction engine, and as such would only be allowed to pass through a village at a speed of two miles an hour.

A DEMONSTRATION against the use of further machinery in the boot trade was recently made at Raunds, one of the large Northamptonshire shoe manufacturing villages. The work is chiefly the making of army boots, and all the manufactures are heavy goods, the lasting being effected by machine methods. W. Nichols and Son have just introduced lasting plant. Three men were obtained from Kettering to work the machines, but they were met at the station by a crowd of 200 and induced to return by the next train. Hostile demonstrations were made by a procession of several hundred workmen, preceded by a brass band.

THE executive of the British Fire Prevention Committee have arranged to test in January next a large timber floor by Millar's Karri and Jarrah Wood Company, which is to show the fire resistance of these Australian hard woods compared with iron and concrete—a subject of the utmost interest to the great dock companies. The attendance of several distinguished foreign experts is anticipated. There will also be some door tests in Karri and Jarrah wood. We understand that among other tests to be expected early next year are tests by the Electric Timber Seasoning Company with treated wood; and by the British Uralite Company with fire-resisting slabs.

AT a meeting this week of the Tunbridge Wells Town Council the Telephone Committee presented a report in which they recommended the raising of a further sum of £15,000 for the purpose of extending the system. The original scheme, costing £10,000, provided for 329 subscribers, but in less than twelve months the Corporation has secured nearly 600 subscribers, and more are being obtained every week. The majority of these have the unlimited service at £5 17s. 6d. per annum, which is the maximum charge. As a result of the competition, the number of local telephone users has increased from 400 to over 1000, and the National Telephone Company has reduced its rates from £8 to £4.

WE have received from Mr. James Mansergh, Past-president of the Institution of Civil Engineers, a circular appeal to engineers on behalf of the Westminster Hospital. The circular states that the necessity has arisen for a very urgent appeal for increased assistance to the hospital. The sub-committee of the Institution, consisting of the writer, Sir Benjamin Baker, Sir W. H. Preece, Mr. W. H. Maw, Professor John Perry, Messrs. H. G. Harris, C. Hawksley, Walter Hunter, Corbet-Woodall, and J. H. T. Ludaberg, accordingly beg leave to suggest that this is a case which all Westminster engineers should regard as demanding special aid outside and beyond their usual subscriptions to general charities. The house committee of the hospital urgently appeal, not only for donations, but for increased annual subscriptions, payable to "The Secretary of the Westminster Hospital, S.W.," to whom I shall be very glad to forward present contributions or promises of future aid.

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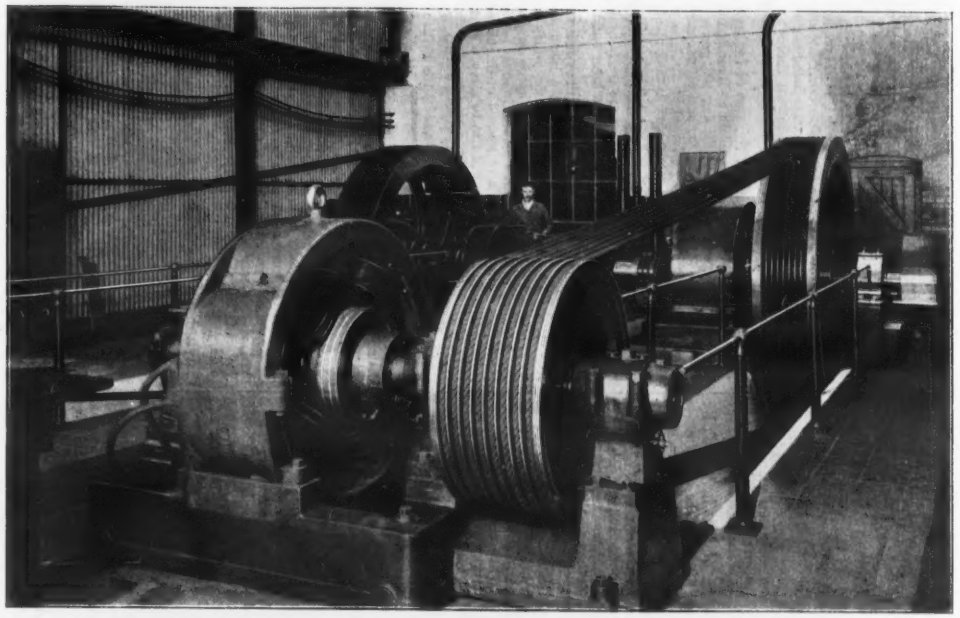
(*For description see page 626*)



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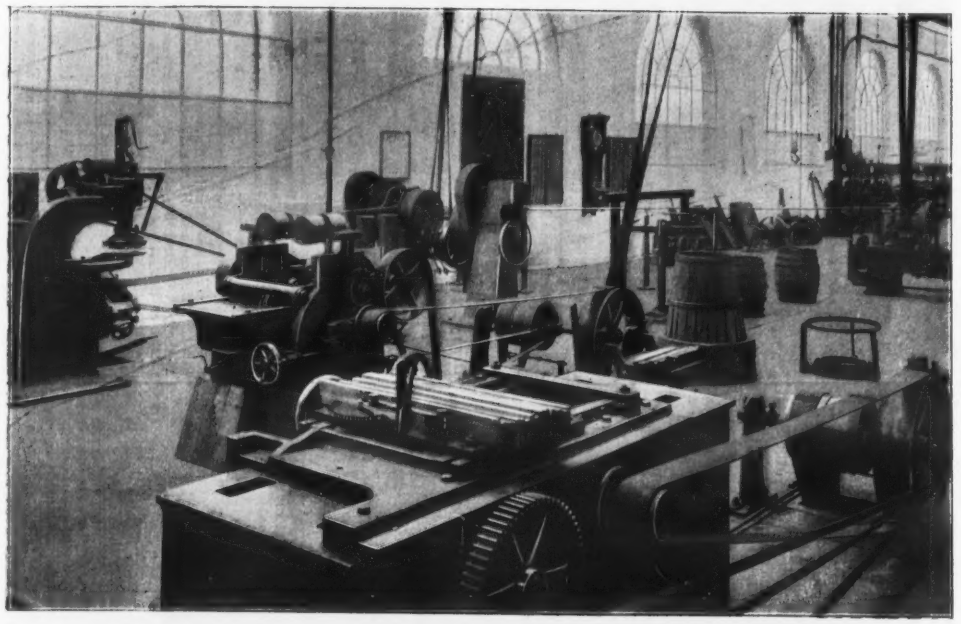

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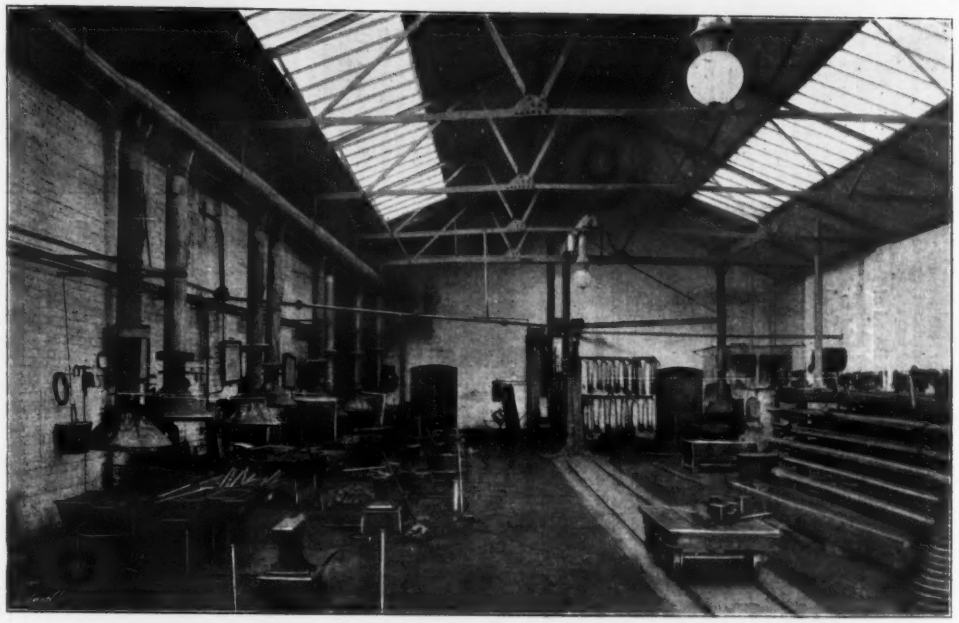

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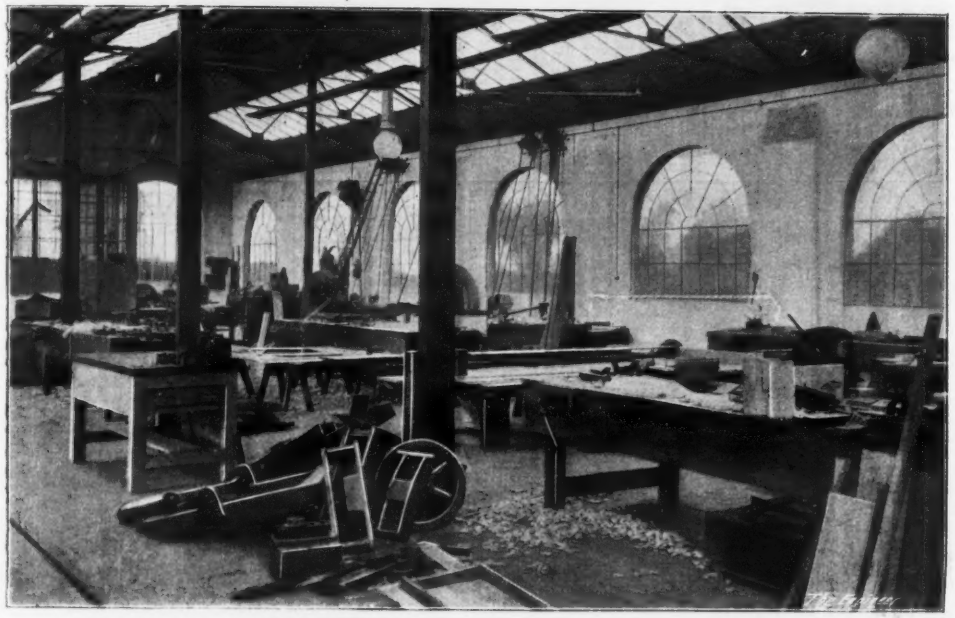

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

R. L. P. (Barnet).—There are practically no chairs used on United States railways.

H. J. S.—Many patents have been taken out for washing smoke. The plan has been tried over and over again, but it has always failed commercially.

R. R. (Govanhill).—It is not at all necessary that the flame should go straight in among the tubes. Very successful small-tube water-tube boilers are made in which the flame circulates back and forwards. When we have seen drawings of the new marine boiler we can form an opinion as to its merits, not before.

ENGINEER (Ravenscourt Park).—The usual practice when oil motors are used is to reverse the tail shaft by a clutch in the boat. The engine makers generally supply these. Mr. McGlasson's address is 29, Dagnall-park, Selhurst. He will tell you where his reversible propeller is made. We do not know the agents of any American type.

A. S (Sydney).—We really are unable to see how we can help you to settle the question of tramway communication in Sydney. The cars in our tube railways are of different sizes. You may take fifty as the approximate number of passengers per car. It is the same with the lifts, some of which are much larger than others, say fifty at a time as an average.

INQUIRIES.

MELTING FAT.

S R.—Could any reader give us the names of the best makers of plant for melting fat for margarine?
London, December 13th. A. W. K. AND CO.

CUTTING OVAL HOLES.

SIR.—We shall be obliged by the address of the present maker of Lyal's oval hole-cutting apparatus. Gordon, Robertson and Co. do not appear to make it now.
Düsseldorf, December 16th. D. F.

THE ENGINEER.

DECEMBER 20, 1901.

BRIDGES IN THEORY AND PRACTICE.

THE earnest student learns the theory of bridges with care, and practices graphic statics with assiduity. He becomes familiar with minute dimensions, and can write with facility of small angles. As his education proceeds, he finds his way into the testing-room, and studies the connection between decimal percentages of carbon, phosphorus, and manganese, and the breaking strength of steel. Developing his mathematics as he goes, he at last reaches the much-desired point when he can design a bridge himself—possibly a very good bridge indeed, in a sense, and one in which æsthetic considerations have not been ignored; and yet the bridge may be from the commonsense point of view, about as bad as a bridge can be. Roughly speaking, bridges may be divided into two principal classes. The first is the big bridge, which, when finished, constitutes a triumph of engineering; such, for example, as the Forth Bridge, and many others, which albeit of less gigantic spans, are scarcely less important. These are one and all special structures requiring special treatment. They bear almost the same relation to the second class that a cathedral does to a village church, or the engines of the Campania to those of a tramp steamer. The second class of bridge is infinitely the most common, and of it alone we are now writing. We may suppose that certain streams have to be crossed, say in one of our colonies, and that half a dozen bridges are required, varying in span from 80ft. to 120ft. Our student proceeds to design these bridges, and when we examine his designs we find that he has very carefully calculated the stress on each member. He has also carefully devised the way in which the various parts are to be secured to each other, and he is very much surprised, and even hurt, when he is told that the structure is wrong from beginning to end. This happens every day. The student is the consulting engineer, always being taught, but learning very little. The bridges are made nevertheless; but that fact is no evidence of the excellence of their designs.

In the manufacturing world certain things are made in quantities, and are, therefore, easily obtained, and they are as cheap as they possibly can be. The wise man buys these things, and makes the best of them. The consulting engineer wants a new coat. His tailor does not possess cloth of the particular texture and colour required. He tries to buy it, and finds it is not in the market. He can have it woven and dyed to his order. The tailor explains to the consulting engineer that he cannot supply the coat in less than two months, and that he must charge £15 for it. Then the engineer is disgusted, and sends to Paris and buys a totally different coat, for which he pays 50f., and afterwards complains to the world that the English tailors are losing all trade and going to the bad generally. If for "coat" we read "bridge," and for "tailor" "bridge maker," we have the case as it stands. Returning to our student, we explain that his bridge is bad because it involves the use of bars and plates and angles which are not to be got in the open market, and will have to be rolled specially, in small quantities, at a very high price, to satisfy the specification, just as the cloth for the engineer's coat would have to be specially woven for him in small quantity and at a huge price. An important bridge was at one time erected in the Place de l'Europe, Paris. It was a road bridge over the railway, and has, we believe, long since disappeared. The specifications for that bridge were prepared with the utmost care and an enormous amount of mathematics. Bars were included in that specification which differed from each other in thickness by half a millimetre. The contract could not be placed. There was not a rolling mill in France that would undertake to roll iron plates under a penalty to $\frac{1}{50}$ of an inch in thickness. The whole of this minute work had to go by the board, and the engineers had to be content with bars which might be as much as 2 mm. too thick. In the Midlands there was at one time an engineer who made pumps. They were largely used in colliery work. He took to himself as a partner a German engineer, quite a clever man. The senior partner did a good deal of travelling, hunting up orders, which he sent to the works. They were not executed as fast as was desirable. He went home to investigate matters. He always put the parts of his pumps together with bolts and nuts which he bought by the sack. He found that the German partner was putting all these through the lathe, and turning them down and re-tapping them. He, in justification of the proceedings, explained that he had carefully calculated the stress on the bolts and found that the bolts which arrived in the gunny bags were too thick. He turned them down to the calculated size. The senior partner admitted that this was magnificent, but it was not business, and he dissolved the partnership. Much the same story is repeated every day in bridge work.

One of the simplest bridges it is possible to make is composed of two lattice girders, with cross beams of rolled steel carried on the lower booms. Such bridges may be successfully made of from 80ft. to 120ft. span, with at most four sizes of bars, every one of which can be had at once from the rolling mills. There will be no gradual reduction in thickness as the stresses diminish, and the bridge will in the long run be no doubt too strong in places and only just right in others. But because the centre panels have bars, say, 8in. wide and $\frac{7}{8}$in. thick, when calculation shows that they ought to be only $\frac{3}{32}$in. thick, can it be rationally argued that the bridge is not a success? Again, a little thought will suffice to show that certain lengths of bar can always be obtained at ordinary market prices, because the original bars can be cut to advantage, without leaving odd lengths, which are too short or too long. Why should not the depth of the girder be such as will suit these lengths? Again, when we come to put the bridge together, it is well known to those who have experience that splendid girders can be made almost without any forged work whatever. It is also, unfortunately, but too well known that in many designs, not only is the smith's work out of all proportion to the result, but rivets have to be driven in almost inaccessible places. These facts have already been dealt with in our columns, and in another page will be found an article from the pen of a manufacturer, which we commend to the consideration of our readers.

Theoretical bridge building consists in preparing admirable designs, in which every portion of the structure carries very nearly the same inch stress; and the work is put together so as to ensure that the attainment of this object shall not be impossible. No regard whatever is paid to the manner in which the materials are to be obtained. Practical colonial bridge building consists in recognising that a certain stream has to be crossed as quickly as possible, and at as moderate a price as may be. Furthermore, in recognising that to secure this end it is essential to be well acquainted with the practice of the rolling mills and the steel merchants, and that the design shall require no bars or plates or angles that cannot be had at a few days' notice, and that these shall be put together in the most simple and straightforward way possible. The object of a bridge is to support railway trains, or wagons and carts, and foot passengers, crossing from one side of a stream to the other, and so long as this is done safely it really matters nothing at all whether the bridge does or does not comply minutely with the conditions defined by elaborate calculation. If the consulting engineer does not know what can and cannot be bought in the open market, it is quite time he obtained that information. If, knowing it, he persists in ignoring the facts, then his perversity is inexcusable. Furthermore, it ought to be clearly understood that a design suitable for a span of 100ft. at one place will be equally suitable for a similar span anywhere else. There has been quite enough of theoretical bridge work done in this country. If we are to hold our own against our rivals we must learn to be practical.

BALANCING LOCOMOTIVES.

ON the 2nd of December, 1862, Mr. Alexander Woodlands Makinson read a paper before the Institution of Civil Engineers on "Some of the Internal Disturbing Forces of Locomotive Engines." This paper was illustrated by diagrams, and elucidated by mathematical investigations printed as an appendix. Its reading was followed by a discussion, in which Messrs. Kitson, T. E. Harrison, F. J. Bramwell, J. Scott Russell, Cowper, Phipps, Sinclair, Gravatt, Kershaw, Molesworth, Vignoles, G. W. Hemans, G. P. Bidder, Reynolds, and others took part. We give the names because they are those of the best men of the day, and Mr.—now Sir F.—Bramwell's masterly investigation of the whole group of questions raised by the paper is a model of perspicuity. Professor Dalby has taken us to task for venturing to say that the subject is exceedingly complex. We commend to his attention Mr. Makinson's paper and the discussion. After he has read these he will, we think, find reason to admit that we are right and he was wrong. At all events, the most eminent men of their day evidently did not hold his opinion concerning a problem which is just the same now that it was then. Before leaving this discussion it may be of interest to say that Mr. Cowper referred to the fact that he had himself used what is now known as the "bob weight" system of balancing the reciprocating parts of engines; and he briefly described a locomotive designed by Mr. Heaton, and tried on the London and Birmingham Railway, which had guides under the footplate, in which reciprocated dummy weights worked by outside cranks

exactly opposite to the inside cranks on the driving axle, so as "exactly to imitate the motion of the piston, but in the opposite direction. This made the engine run very steadily indeed." Many of our readers will no doubt remember that a very similar system of bob weights under the footplate was applied to a locomotive shown at Versailles in 1900, history repeating itself.

In two previous articles we have dealt in somewhat general terms with the balancing of the rotating portion of the mechanism of a locomotive engine; we now propose to consider the so-called balancing of the reciprocating machinery. But before doing this, it may be advisable to say a few words as to what this balancing means. We must refer our readers who want a full consideration of this point to the "Transactions" of the Institution of Civil Engineers, vol. xxii., page 65, *et seq.*; but since Professor Dalby has laid so much stress on the word, and seems to desire to treat the engine apart from the road, it is necessary to explain that the motions produced by want of balance of any kind, even in a suspended engine, are extremely small. They are to be measured, indeed, in fractions of an inch, and can in no way account for the actual lurching, jumping, or swinging that occur in a locomotive. In a word, the mass of a locomotive as compared with that of the parts out of balance is so great that the range of motion produced by the want of balance must be small, a fact very clearly brought out by the discussion of forty years ago. Hence the bare abstract mathematical investigation of balancing questions as affecting the engine itself are, as we have said, only of academical interest. They have no practical bearing that is not included and overborne by the far larger problem presented by the disturbing forces set up in a locomotive regarded as one part of a machine, of which the rails form the other portion. We might, indeed, as well deduce from the oscillation of a planing machine table hung up by the four corners and allowed to swing like a pendulum, the power required to traverse it when sliding on the V guides of its bed. The locomotive must be treated as a machine running on rails and driven by reciprocating mechanism, if we want to investigate the causes of its unsteadiness and ascertain the best way to overcome them.

Leaving out of consideration, then, the effect of balance weights for the rotating masses, let us consider the effect of those introduced to balance the action of the reciprocating masses. In the first place, it should be clearly understood and emphatically asserted that masses revolving in a circle cannot balance straight line forces in any system of reciprocating mechanism. This is now fully understood by makers of high-speed engines; the bob weight principle has taken the place of all other schemes of counterbalancing. That is to say, the reciprocating masses of several engines play the part of bob weights to each other. But the rotating weight can be of use as a compensator though not as a balancer. Mr. Arthur Rigg was, we believe, the first to point out that the stresses due to the inertia and momentum of reciprocating parts might be regarded as centrifugal effort referred to the crank pin. At all events, he was the first to state the fact clearly. We constantly see the words "centrifugal force" in print, and the popular idea is that a revolving weight, say a stone tied to a cord and swung round and round, would fly away radially if the cord broke. "The stone pulls on the string," it is said. Now if we may be allowed to use something like a paradox, we shall say that the stone does not pull on the string, but the string pulls on the stone, continually dragging it inwards from the straight tangent which it desires to follow. In the same way, when a piston has reached the end of a cylinder, the crank has to drag the piston away from the end of the cylinder, and the force required to do that is just the same as if the whole reciprocating weight were centred on the crank pin. But mark the difference. As the crank continues to revolve, this centrifugal effort dies away until it becomes nothing when the piston is moving at its maximum speed, and then it climbs up again, but with an opposite sign, as the piston slows down, and is again a maximum, the sign changing again, the moment the crank passes the dead centre. Applying this to the locomotive, it will be seen that if a certain quantity of weight is put into the driving-wheel rim, opposite, or very nearly opposite, the crank, its centrifugal effort will balance the centrifugal effort of the reciprocating parts, but only when the crank is at the dead points. For the centrifugal effort of this compensating weight will be constant, while that of the piston, &c., rises and falls, absolute coincidence only taking place when, as we have said, the crank is at the dead points. When the crank is straight up or down, the compensating weights are wholly unbalanced, and they are responsible then for what is known as "hammer blow." Indeed, because the effect of this unbalanced action would be so great, no attempt is made to compensate completely for the so-called centrifugal effort of the reciprocating parts, only from one-half to two-thirds of the weight of the piston, rod, crosshead, and connecting-rod being put into the driving wheels.

The theory of balancing as worked out by Professor Dalby is applicable to an engine itself hauled along the road. Let us suppose, for instance, a modern express "dead" engine to be hauled by another locomotive at sixty miles an hour. This would then represent a certain set of conditions. We have shown that so long as the wheels are in contact with the rails, it matters nothing how far the engine is out of balance, there can be no up-and-down vibration in which the permanent way does not take part. Only longitudinal vibrations can be set up, and these resolve themselves into attempts to twist the engine back and forward across the line. All this has already been very fully discussed. We do not think that any one will attempt to maintain that the forces tending to make an engine unsteady can be the same when steam is on and steam is shut off. Let us take, for example, the effect of centrifugal effort as a compensation for the inertia and momentum of the reciprocating parts. We have explained that the piston has to be forcibly dragged away from the end of the cylinder; but it ought to be clear that the amount of force required to do this will be less if there is a stress of 30,000 lb. or so due to the steam admitted to the cylinder helping to accelerate the piston than will be the case if there is no steam entering the cylinder. The compensating weights required in this case are very much less than would be required if steam did not act on the piston. But there is yet more than this to be considered, and we are about to show what one of the most important functions of the balance weight really is—a function which, so far as we know, has been entirely overlooked hitherto. Let us suppose the case of an engine with single driving wheels, 20ft. in circumference, and moving at sixty miles an hour, or 88ft. per second. Let us further suppose that the balance used in the wheel rim is 100 lb., intended to compensate for the reciprocating weights. The velocity of the engine is 88ft. per second; that of any point in the tire vertically above the centre of the driving axle is 176ft. per second. As the balance weight will not be in the rim of the wheel but inside it, we may assume that it, when at its highest point, will have a velocity of 160ft. per second. Now this means that the balance weight will have stored in it at the moment an energy of 40,000 foot-pounds. We may regard the balance weight as secured to the top of a lever, the lower end of which finds a fulcrum on the rail, the balance weight being projected forward in space, and pulling the lever with it. Against this movement we have the thrust of the piston. The radius of the circle described by the balance weight is, say, 6·5ft., the centre being on the rail. The crank is 1ft. long, and the crank pin centre distant from the rail 2·5ft. The forward effort, therefore, of the balance weight on the crank pin is 104,000 4·6-inch-pounds. It is well understood by this time that the action of the steam tends to send the axle-box against the back hornplate when the steam is in the forward end of the cylinder. It will be seen by those who have followed us that the balance weight tends powerfully to prevent this, and so tends to equalise the efforts and stresses going on in the engine. Of course, it must be understood that this compensating action fluctuates in amount. Those who are familiar with graphics can easily work out the stress curves for themselves. The difficulty of dealing with this subject arises very largely from the circumstance that all the stresses are constantly changing in direction and amount.

We have, we think, made it abundantly clear that absence of balance cannot make an engine jump or roll. It cannot impart directly any vertical movement whatever, save in so far as the rails are made to spring. Want of balance can impart longitudinal oscillations, which resolve themselves into sinuous movements. Concerning these, finally, we quote the following passage from Mr. Makinson's paper: "In considering the tendency to produce a sinuous motion—a tendency to move transversely to the rails first to the right hand and then to the left—it will be necessary to include the steam pressures in the cylinders among the disturbing forces. Both the classes of disturbing forces hitherto alluded to—those arising from the revolving and reciprocating parts—are entirely independent of the action of the steam in the cylinders; their magnitude is determined by the velocity of the engine and the proportions of its parts, and that being the same, remain unaltered whether the engine is running with steam on or steam off. But in the modern locomotive, with two cylinders, and cranks at right angles, the very action of the steam which propels the train may fairly be classed among the disturbing forces of the engine; its tendency is exactly the same in character as that of either class of the disturbing forces before alluded to. It is only by studying the action of the steam pressure in its character as a disturbing force—firstly alone, and then as combined, or in its joint action with the other disturbing forces—that the merits or demerits of the modern two-cylinder locomotive with regard to its stability on the rails, its action on the permanent way, its essential resistances, and the wear and tear of parts can be properly appreciated."

THE GERMAN ELECTRICAL ENGINEERING TRADE.

At present, and for some time past, the German electrical engineering industry has been suffering from the severe depression which affects most trades in that country, and it is not a difficult matter to assume that in this state of affairs lies an explanation, at all events to some extent, for the keen competition which Teutonic firms are now offering in the English markets. Whether this rivalry will become of a permanent character remains to be seen, but everything tends to indicate that British firms may expect a continuation of German competition in the supply of electrical engineering plant for a long time to come. It is a remarkable coincidence that, in so far as public contracts are concerned, the zealous attentions of our trade rivals became accentuated simultaneously with the commencement of the decline in the Fatherland about two years ago, and with the formation of branch establishments with British titles, under the Companies' Acts in operation in this country. The record of some of the companies during the past financial period—that is, in the first completed year since the reaction in trade—is not so happy as in the preceding year, although the extent of the depression will probably not be fully experienced until the termination of the working year now in progress. For instance, the dividend of the Allgemeine Elektricitats Gesellschaft has receded from 15 per cent. to 12 per cent., that of the Siemens and Halske Company from 10 per cent. to 8 per cent., and that of the Lahmeyer Company from 11 per cent. to 10 per cent. On the other hand, the Schuckert Company, which paid 15 per cent. in the previous year, has been compelled to pass its dividend, and in doing so it has been emulated by its allied trust, the Continental Company for Electrical Enterprises, of Nuremberg, which distributed 7 per cent. in the preceding twelve months. The Helios Company shows, however, to the greatest disadvantage, inasmuch as the dividend of 7 per cent. declared for 1899-1900 is reported to have been converted into a deficit of over £400,000 for the past year, whilst its kindred trust, the Cologne Company for Electrical Installations, actually exhibits a loss exceeding £260,000. Yet the Helios Company recently submitted one of the six lowest tenders for the plant required for the London County Council tramways.

The extensive international ramifications of the first three companies, and their abstention from rash speculation in electrical undertakings of various kinds, are doubtless responsible for the decline in the respective dividends being only of comparatively moderate extent, although it is possible that the rates of distribution may be effected on larger amounts of share capital than in the previous year. On the other hand, the remaining companies have found speculation rather an expensive matter; and some time must necessarily elapse before they will be able to place themselves upon a firmer financial basis. Apart from these companies, there have been several failures which have caused considerable distrust throughout the country in regard to electrical investments; and the question not unnaturally arises as to what the German electrical engineering companies in general intend to do in order to keep their works in operation. The capital of individual manufacturing companies during the past few years has been increased to as much as £1,000,000, £2,000,000, and even £3,000,000; their works have assumed enormous dimensions; they employ thousands of officials and workpeople, the Siemens and Halske Company alone having 14,374 persons in its employ at the beginning of October; and some of them have established branches in different cities in Europe and in other parts of the world. These international connections are, of course, not the backbone of the industry, but, as the managing director of one of the principal companies recently remarked, they ensure a regularity in the receipt of orders from abroad. This is quite true, but what about keeping the shops fully employed? There has been a slackening in tramway construction, lighting stations, plants for the transmission of power, and, in fact, for all classes of work of large proportions, and important manufacturing companies have actually entered into competition with wiring firms in order to obtain insignificant contracts. The Allgemeine Elektricitats Gesellschaft has endeavoured to form a working agreement with the Schuckert Company, with a view to the regulation of prices and business methods; but the negotiations on the subject have so far led to no practical result. It has been suggested that if this scheme could be brought into operation, other companies might be invited to join the projected organisation; but the smaller concerns, which have already had a taste of the competition of the larger companies, do not regard the proposal with any favour.

Is it any wonder, then, under the depression prevailing in the Fatherland, that German companies should endeavour to extend their business in the United Kingdom at any price whatever? The words "at any price whatever" may be read advisedly. It is only a short time since one of the leading German companies, in referring to competition in Germany itself, stated that some of the firms manufacture and sell without any regard to the cost whatever. If our trade rivals practise this policy at home, why should they not do so in England? They are, apparently, prepared to make a sacrifice in price in order to insert the thin end of the wedge, or, in other words, to obtain an advertisement, and they are doubtless willing to accept contracts which, although not remunerative in themselves, will yet assist in keeping the works going, and thus reduce the standing expenses. Is it, therefore, unreasonable to assume that the any-price-whatever policy is being practised in this country? It is not unreasonable. The difference in the rates of wages and hours of labour in the two countries, apart from the cost of materials, can in itself scarcely account for the disproportion between German and English tenders for electrical plant; and we are forced to the conclusion that the sole object aimed at by Teutonic firms is to obtain a market, irrespective of initial difficulties and expense, in the hope of recoupment at some future period. But there is another point which deserves consideration. Many of the English local authorities insist upon the insertion in contracts of clauses stipulating for the observance of trade union rates of wages and hours of labour. Now, if any of these particular authorities have accepted, or propose to accept, German tenders, it would be interesting to know whether such clauses have been inserted in the contracts or are proposed to be embodied in them. If the clauses have been abandoned, this would be a distinct injustice to the English firms tendering; but if they have been retained, how will it be possible to enforce the conditions in Germany? This is a matter which requires careful consideration in the settlement of future contracts which our competitors may seek to wrest from us.

THE STEEL PLATE COMBINATION.

Rumours have for some time past been in circulation telling of a great American steel combination to rival the United States Steel Corporation. They have not been deserving of full credence, because, although there are still a number of independent establishments here and there in the country, there are scarcely enough to form an amalgamation which would be in any sense a competitor on equal terms with what is sometimes called the "giant trust." The Republic Iron and Steel Company, the Colorado Coal and Iron Company, the Tennessee Coal, Iron, and Railroad Company, Jones and Laughlin, and the Sharon Steel Company would form a nucleus for a very important consolidation of interests, but they would fall a long way short of the Steel Corporation's magnitude, and the difficulty of financing it would be very serious, since some of these units having already been through syndicate reorganisation, are now capitalised well up to high-water mark, and could not make a showing of increased earnings to warrant additional dilution. Futhermore, it is vigorously denied that any of these concerns is interested in the proposed consolidations; and as the Steel Corporation has so far proved to be a very indulgent tyrant, and does not worry others to help it to keep up prices, there does not appear to be sufficient reason

for setting up a sort of opposition which might cause it, in certain conceivable circumstances, to make a show of its strength. So long as the Trust permits the leading outsiders to secure profits on a scale which might in other conditions be impossible, so long may outsiders be expected to follow the excellent example of Brer Rabbit—and lay low and say nothing. But a combine which has certainly been accomplished is one comprising the most prominent plants in the plate industry—the Lukens Iron and Steel Company, of Coatesville; Worth Brothers Company, of the same place; the Tide Water Steel Works, of Chester; and the Central Iron Works, of Harrisburg. They are reasonably close together, can be operated in harmony, since they all reach the same markets in competition, and it is argued that they will be in a better position working together than working independently, especially in the matter of administrative and selling expenses. Whether some of the shipbuilding plants which are such extensive consumers of plates will be taken in seems to be still undetermined. But if they are it will be a good thing for American shipbuilding. One of the greatest disabilities under which that industry suffers to-day is the inability to secure plates save at the extravagant rates ruling—thanks to the protection of the tariff—in the domestic market. The most noteworthy feature is that the Steel Corporation is at the back of the plate combine, and when we know this we have realised that the deal is merely a means of extending the sphere of influence of that corporation.

STEELWORKERS' WAGES.

THE question of foreign competition is just now bringing the matter of steelworkers' wages to the front, and in more than one part of the kingdom the employers are urging that this class of labour is too highly paid. Especially is this the case in those districts where German steel is at present figuring as a competitor with the native product for British consumers' patronage. So long as native steel makers have the consuming market pretty much to themselves, and have only to contend against internal competition from rival English districts, they do not find the high wages paid in the steel mills more than they can manage, but when the foreigner is pressing, and selling prices are consequently reduced below the normal, then it is that a demand for relief is raised. The condition of things existing in South Wales is an illustration in point. There the steel masters are preferring a request for a reduction in steelworkers' wages owing to the increasing importations of German steel in the shape of tin bars and billets. The Welsh masters point out that the Principality is alone among the steel districts of the kingdom in depending for its prosperity upon a single industry, namely, that of tin-plates. In the great sister districts of the West of Scotland, the North of England, South Yorkshire, and even the Midlands, a much greater variety of trades is ministered to. When the foundation industries of shipbuilding and armour plate manufacture, with their magnificent and constantly increasing consumption, are slack there are lesser trades to supply the steel mills with orders. It is the tin-plate trade, too, with its consumption of tin bars and billets for rolling down purposes, that is just now being chiefly affected by the importations of German steel. Many thousands of tons of this material are coming into Wales for tin-plate manufacture, at prices anything between 12s. and 15s. per ton below Welsh quotations, and it was the same in the period of the American competition in steel. Last May the Welsh employers reduced steel bars by £2 per ton to meet the American competition, and the operatives in the steel mills then declined to make any concessions. This course they seem likely to repeat upon the present occasion, unless more reasonable counsels prevail. The situation is interesting, the employers pointing out that they are engaged in and entirely dependent upon the tin-plate industry, and that as long as the tin-plate roller earns only £2 10s. per week, there is no reason why the steel bar roller should earn £6 and the steel smelters anything above £5 per week.

WIRELESS TELEGRAPHY ACROSS THE ATLANTIC.

IT is announced by Signor Marconi that he has succeeded in transmitting signals across the Atlantic Ocean on his now well-known wireless system. Far be it from us to say that this is impossible. We hasten to add that the statement lacks confirmation. Very vague, indeed, is the information available. So far as it goes it is to the effect that a couple of letters have been transmitted through the atmosphere from near the Lizard to a place in Newfoundland known as Signal Hill, on Thursday or Friday. The letters in question were S and R. Now, it so happens that Signor Marconi has not a monopoly of aërial electric currents, and it has long been known that stray currents will simulate the signalling of letters, and S and R happen to be those most often imitated, if we may be allowed the word. It is by no means impossible, therefore, that Signor Marconi's S has nothing to do with any message sent from Cornwall. Experts at both sides of the Atlantic await further developments before pronouncing an opinion. Signor Marconi is erecting signal poles 200ft. high, but the work has been delayed by heavy gales. Meanwhile, Signor Marconi has received a letter from the solicitors to the Anglo-American Telegraph Company warning him that the company possess a monopoly of the right to construct and work any and every system of telegraphy in the Colony of Newfoundland. It will be strange if the monopoly should be held to cover a discovery which could not possibly have been contemplated at the time the company was incorporated. It is stated that the Governor of Newfoundland and various members of the Government have visited Signal Hill; but Signor Marconi announced that in consequence of the hostile attitude of the Anglo-American Company he thought it advisable not to conduct any further tests; but in order that the visitors might not be entirely disappointed, he exhibited his balloon, kites, batteries, and other apparatus. He afterwards informed those present that the experiments at St. John's were now concluded, and that the balloon and other equipment would be packed for early shipment, probably to Halifax, Nova Scotia.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineer: S. Aston, to the Grafton, to date January 14th. Engineers: E. P. Soper, to the Pembroke, for the Grafton, to date December 17th, and to the Grafton, to date January 14th; and W. A. Donovan, to the Trafalgar, to date December 17th. Assistant engineers: C. E. Russell and W. S. Damant, to the Pembroke, for the Grafton, to date December 17th, and to the Grafton, to date January 14th; H. W. Grant, to the Sans Pareil, H. Clift, to the Pembroke, for the Bacchante; and J. C. N. Webber, to the Furious, to date December 17th. Probationary assistant engineer: H. Hodson, to the Pembroke, for the Grafton, to date December 17th, and to the Grafton, to date January 14th.

SIR JAMES LAING.

WE have to record with regret the death of Sir James Laing, J.P., D.L., the well-known shipbuilder, of Sunderland, which took place at his Northumberland residence of Etal Manor, near Ford, on the morning of 15th inst., after about a fortnight's serious illness. Sir James, who had attained to the ripe age of seventy-eight, for a long span of years filled a very large place in the industrial, commercial, and social life of the North of England, and in him Sunderland has lost perhaps her chiefest citizen. He was the only son of Mr. Philip Laing, who hailed—like others who might be named as having risen to eminence in shipping, *e.g.*, the Hendersons, of the Anchor line of steamers—from Pittenweem, in Fifeshire, N.B.; and in 1793 commenced shipbuilding on the Strand, Monkwearmouth, in partnership with his elder brother John. These two founded the business which, on another site, as the Deptford yard, has since been developed by Sir James Laing so as to take rank with the leading shipbuilding works in the world. The firm of John and Philip Laing built some fine ships for those days, and in 1804 the brothers opened a graving dock close to the Monkwearmouth Bridge. It is claimed that Mr. Philip Laing was the first to introduce chain cables in place of hempen ropes in the equipment of a vessel, this being the Kent, of 195 tons burden, built about 1815. Chain cables did not come into very general use till 1823. In the year 1815, also, Philip Laing built the Caledonia, 110ft. in length and 414 tons measurement capacity, which was one of the first free-traders to enter upon trade in Eastern waters after the charter of the old East India Company had been altered and free trade granted. In May, 1818, the brothers split partnership, and about the same time the property on which the establishment has since grown was bought by Philip Laing. His son James was born amid the scenes in which, in after years, he was destined to achieve such signal success, for his father's home, Deptford House, was contiguous to the shipyard. He began his career as a practical workman in his father's yard, and readily acquired an intimate knowledge of shipbuilding in all its details. In 1845, the jubilee of his father's commercial career, the conduct of the business was handed over to him, and, being then about twenty years of age, young Laing took up the reins resolutely, and was soon carrying on matters with even greater success than his father. His first vessel was the Agincourt, built as a speculation, but soon sold, and orders for others quickly followed. About this time he began to employ East India teakwood for the exterior planking of high-class vessels, while the frames were of the best English oak. He adopted this practice—importing for the purpose the first cargo of Moulmein teak into Sunderland—because he had observed that the yellow metal bolts which were then used were not so liable to corrode when driven through the teak as through oak. Just about this time, however, the controversy as to iron *versus* wood in shipbuilding was waxing strong, and instances of the substitution of iron for wood on the increase. Happening to be in Liverpool in 1848, James Laing took the opportunity of visiting the iron steamship Great Britain—built at Bristol in 1843—as she lay in her battered condition on the beach in Dundrum Bay. His examination of the vessel, and the way in which it had withstood a whole winter's stranding, quite satisfied him that the time for a change from wood to iron had come. With the foresight which ever characterised his actions, he very shortly set about devoting one of the Deptford yards to the construction of iron vessels. He began operations in iron in 1852, and in the year following launched the Amity, 167ft. long, the first iron vessel built on the Wear. A year later came the Vulture, a steamer which was still afloat at the beginning of this year. The building of iron and wood ships together continued till 1866, when timber was entirely superseded at Deptford, the last vessel of wood being the Paramatta, 230ft. long, registering 1615 tons. To secure greater rigidity, and counteract the tendency to "hogging" in wood vessels, Laing very early introduced the system of diagonal strapping the wood framing, his method being to score out the frames to admit of iron straps being fitted flush with the outer surface, and led diagonally from the gunwale down to the floors, and through connected to all parts. Of composite vessels proper, in which the framing was of iron, and planking of timber, he built a number, the best example perhaps being the Torrens, a full-rigged ship, which made the passage from London to Adelaide in sixty-four days. Gradually, under Mr. Laing's directions, and in due time with the able assistance of his sons, the business grew, until it reached its present proportions, when it has as many as 600 vessels to its credit. The firm has turned out work for some of the largest shipping companies in this country and abroad, including such high-class lines as the P. and O., Royal Mail, Union Line, West India and Pacific, British India, British and Colonial, &c., and the extent of the business at present may be gauged by the fact that during the year 1900 the output comprised eight vessels of an aggregate tonnage of 40,307 tons; this being at the head of the returns of the thirteen shipbuilding firms on the Wear for that year. One of the firm's specialities is oil-carrying ships, of which they have built a large number, including the Tuscarora for the Anglo-American Oil Company, the largest vessel of this description afloat at the time she was launched; while they are also builders of a patent description of steamer, known as the "trunk" type, of which they have this year produced two of 7500 tons for the Hamburg-American Line. The Deptford shipyard covers an area of 17 acres, on which are six berths, yielding an output capacity of between 40,000 and 50,000 tons per annum. The number of hands employed is about 2500. There are connected with the shipyard large graving docks, and brass and copper works of an extensive character.

In September, 1893, the centenary of the shipbuilding business and the jubilee of Sir James as a shipbuilder were celebrated, an enthusiastic demonstration being made by the workmen and people of Sunderland generally, and Mr. and Mrs. Laing presented with their portraits and an illuminated address. The chief public work of the deceased was his labour on the River Wear Commission; and the position of Sunderland as a port to-day is due in a very large measure to his energy and prescience. He served on the Commission from 1859 till 1900, having been chairman uninterruptedly since 1868. He inaugurated his reign as chairman by opening the Hendon Docks, which, together with the channel to the sea, cost about £300,000. In 1881 he moved the resolution in pursuance of which the constructional work of protecting the piers at the harbour entrance was begun, and in 1885 he laid the foundation stone of the Roker pier, which is now practically completed. In 1896, in recognition of the valuable services rendered, his brother commissioners presented him with his portrait in oils, and on April 25th, 1900, after intimation had been given of his retirement from office, they presented him with a magnificent silver salver. While thus, locally, Sir James was a power making for progress, in a wider field he was also recognised as a leading force. In 1883 he was chosen President of the Chamber of Shipping of the United Kingdom, and as an official representative of that interest he did signal service, especially in securing modifications in the Shipping Bill, which Mr. Chamberlain introduced into Parliament, and in heading a revolt of the shipowners against the regulations and charges levied by the Suez Canal Company, which was eventually the means of an amicable settlement being come to which satisfied the canal directors, the Government, and the shipowners. Mr. Laing subsequently became a director of the Canal Company, and only retired as recently as last spring. He served on the Board of Lloyd's Registry for over thirty years, and he was also a member of Council of the Institution of Naval Architects. He was a member of the Sunderland Chamber of Commerce, a Justice of the Peace for the counties of Durham and Northumberland, and had also held the position of High Sheriff for Durham. The honour of knighthood was conferred on Mr. Laing at the New Year of 1897. Sir James was twice married. By his first wife he had a son and daughter, both of whom are living; and by his second wife, Lady Laing, whom he married in 1855, and who survives her husband, there have been thirteen children—five sons, two of whom are dead, and eight daughters, all of whom are alive.

ENGINEERING WORKSHOP ORGANISATION.

AT a meeting of the Manchester Association of Engineers on Saturday last, Mr. A. P. Loscher read an interesting paper on the above subject. After referring to the excellent results obtained in the United States, and in later years in Germany, by modern workshop organisation and specialisation of production, Mr. Loscher remarked that it was somewhat surprising similar conditions had not been adopted more universally throughout engineering works in this country. Perhaps one thing which had proved a very serious hindrance to modern workshop organisation, and almost threatened to be a national calamity to the industrial welfare of the country, was the present development of trade union principles, especially those which were in actual practice in most factories. Dealing with the classification of works' orders, the chief objects of which, he stated, were saving of time and avoidance of mistakes, Mr. Loscher expressed the opinion that the card system for entering and transferring works' orders seemed to have achieved those objects most satisfactorily, and proceeded to describe in detail a system of cards he had himself adopted, which, he observed, was now in successful operation, in a factory where both repetition and jobbing work of a great variety were produced, partly for stock and partly for customers' orders. Discussing the general question of workshop management and practice, Mr. Loscher said that although much had been written during the last two years in nearly all the leading engineering journals about the advantages of the intensified or differential rates system, he had not heard of its adoption by any factory here. The fixing of rates by scientific methods, and the fixing of maximum outputs for men and machines, were the foundations for economical and successful production. The differential rates system offered better terms to the willing and industrious workman than any trade union was trying to secure for any of its members. When a member of the trade union he would be restricted from earning more than 25 per cent. above the recognised district rate of wages. How severely the consequence of such principles as that had told upon the productive capacity of this country, the British manufacturer, who experienced daily the keen competition of other nations in the world's markets, could furnish proof.

Absolute want of even the most elementary education amongst a large number of the working men made it very often an extremely difficult matter to introduce any new system of organisation, pay, or machinery. The excellent facilities which were given at the present time by the numerous technical evening schools should be taken full advantage of, and a beginning should be made by compelling every apprentice to regular attendance. Another difficulty he had come across was the constant objection of apprentices to perform certain operations on machines or to do any one class of work during a certain time, as they seemed to think no experience would be gained thereby—an opinion in many cases apparently inspired by men who mistakenly fancied their interests as a productive class might be endangered by such lads performing certain operations with the assistance of machine tools. In a properly-organised workshop boys should be given to understand that it was necessary to begin elementary turning on a simple capstan, and afterwards, if possible, on a combination lathe and capstan, and then on a screw-cutting lathe for completing apprenticeship to general turning. Similarly, an apprentice to fitting, who had been taught to lend a hand to the milling, planing, and drilling machine, or shaper, and had been made acquainted with pneumatic tools and grinding machines, would certainly be a more skilful workman than one who had made himself conversant only with vice, bench, file, or chisel. Great attention must be paid to the tool room, which must be kept well-organised and up to date, and to the lighting, ventilating, and sanitary arrangements of the workshop. Mr. Loscher also recommended the adoption of boxes for the reception of suggestions from the men, and periodical conferences between the works manager, foreman, chief draughtsman, and head storekeeper. Broad principles and modern conveniences for the employés should be accompanied by strict business-like supervision of labour and its proper protection, and it was well for the general prosperity of an engineering district to stand by and enforce every point decided upon between employers for their mutual benefit.

Mr. Arthur Hobbs remarked that the author had not insisted on the importance of the drawing-office, which had now taken up such a prominent position in the organisation of engineering works. Mr. Walter Yates said that at his own works they had classification—a system with only one card for each specific operation. Mr. Collier observed that elaborate and efficient systems of workshop organisation were in operation in English engineering works to a greater extent than the author appeared to think, and Mr. James Bolas and Mr. E. G. Constantine supported this statement. Mr. Wm. Ingham thought an elaborate card system might in practice be found so cumbersome that the time of the workman would be expended in carrying out the system instead of turning out the work.

POST-OFFICE LONDON DIRECTORY FOR 1902.—We have received from Kelly's Directories Limited, High Holborn, London, a copy of their annual directory for next year. Although the new edition exceeds in bulk any of its predecessors, containing over 3350 pages apart from advertisements, no new features appear to have been added, indeed it would be a matter of difficulty to suggest scope for such. To keep it well abreast of the times every division of the volume has been corrected as usual down to the latest possible date. As an instance, we note that the appointments to the Princess of Wales's household, which were gazetted as recently as December 3rd, are given in the official section, together with other important appointments equally recent. In such an immense work too much attention cannot be given to the binding, and in this case a serviceable leather cover has been provided, which will defy average treatment for a long time to come.

ELECTRICALLY DRIVEN DRILLING MACHINES.

THE increase in the use of electricity in machine shops has naturally directed the attention of machine tool makers to special electrical tools, but it will be acknowledged that in the majority of cases it is rather the practice to attach a motor to an existing design than to make the motor an integral part of the whole. This is less the case with drilling machines possibly than with other tools, and several excellent designs in which the motor is essentially a part of the whole, not an adjunct which is fitted or not as desired, are now built. On this and the next page we illustrate several machines made by Mr. Asquith, of Halifax, which will, we think, be found interesting.

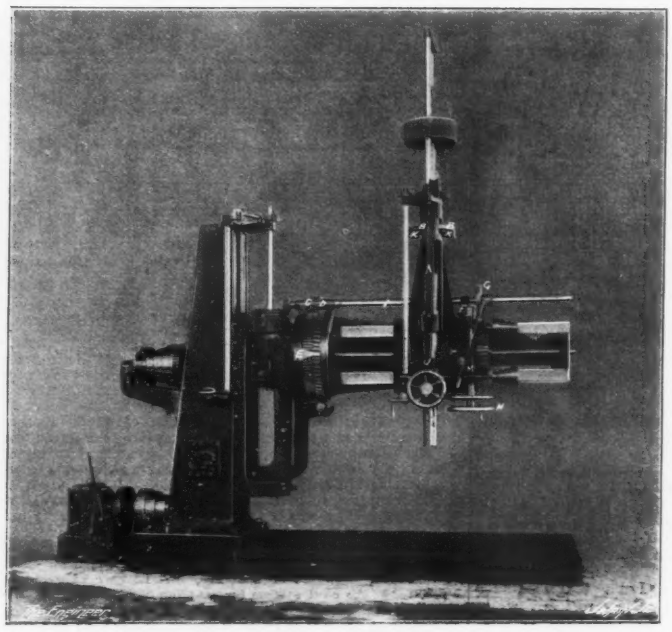


Fig. 1—7ft. 6in. RADIAL DRILLING MACHINE

Fig. 1 represents a radial drilling and boring machine, with 7ft. 6in. radius, and admitting a maximum height of 6ft. under the spindle. The arm can be raised and lowered 2ft. 9in. by power; the shaft for throwing it in and out of gear can be seen in the engraving. The spindle—hard steel—is 4½in. diameter; it has a hand and variable self-acting feed motion of 3ft. 3in.; it is balanced and provided with quick motion for rapid and easy adjustment. The end is bored out to No. 6 Morse's standard taper, with provision for driving boring bars. Sixteen changes of cutting speed are provided for, suitably graded for working up to the maximum diameter. For tapping the spindle runs at a slower speed than when drilling, without changing the belt on the cone, and reverses at a higher speed by moving a lever handily placed under the workman's control. The mitre and bevel gearing, and the spur driving gearing on the spindle slide, is of steel. The special motions made by this firm for adjusting the spindle in all directions are embodied in this machine, enabling the spindle to be adjusted along the arm, or radially around the base-plate, quickly and accurately, without the attendant leaving the work being operated upon.

It will possibly be worth while to explain these motions in greater detail. The radial arm can be rotated axially for drilling holes out of vertical, as well as swing horizontally. For the latter operation the large hand wheel H, Fig. 1, is revolved, It carries a worm F, which, gearing with the worm wheel G, rotates the shaft I, to which is keyed the pinion D. This pinion engages with a large wheel loose on the end of the arm. This wheel in turn drives C, keyed on a small bevel wheel spindle. The corresponding bevel wheel being keyed to the top bearing, rotation of the small pinion causes the arm to swing round. The object of the interposition of the large loose wheel is to permit of the axial rotation of the arm. The worm wheel G can be slid in or out of gear by the lever shown. The balance wheel above H can be coupled to it by a ¬-shaped pin. Worm M is thus driven, and drives the rack pinion, so that careful radial adjustment may be made. Axial adjustment is made by worm wheel on the end of the arm; the pointer E shows the angle on a graduated scale. The feed is effected by a split nut on a long screw on the end of the drill spindle. The two halves of the nut are on the levers B B, centred at K K, and are moved by the cam lever A, at the lower end of which is the handle J. This lever is moved up and down and moves the levers B B, by two inclined slots in its upper end. This whole arrangement provides as complete localised control of the machine as it is possible to conceive could ever be required. It certainly leaves nothing to be desired in the matter of handiness. The machine, complete with portable box table, weighs 14 tons.

On the next page is illustrated a similar machine, only without swivelling arm. This machine has reversing motion for tapping, and has all the features for quick and accurate adjustment of spindle in all directions as in the former machine. It has 6ft. radius of spindle, and admits 6ft. in height under spindle. Its approximate weight with portable box table is 9 tons. Mr. Asquith has made a large number of these machines, those illustrated being two of a number recently supplied to H.M. Government dockyards.

The use of portable machine tools of various description is rapidly increasing. Fig. 2 illustrates such a machine made by Mr. Asquith. By reference to the illustration it will be noticed that provision is made for slinging direct on to a crane hook, and so moving to the desired position. These machines have been made for use on large work tables, where large electrical work is being built, and moved about to the work requiring machining, instead of having to move heavy pieces to the machines, thus effecting a great saving in cost.

The machine illustrated has a radius of 4ft. 6in., and will admit a maximum height of 5ft. 10in. under the spindle when the arm is elevated to its highest position. The arm can be adjusted 1ft. 4in. in height by hand power. The spindle is 2½in. diameter, balanced, and it can be instantly raised or lowered to the desired position; it has a hand and variable self-acting feed motion of 24in., and can be used for tapping and inserting studs, provision being made for instantly changing the speed of the spindle when reversing. The machine is arranged with a double gear bolted to the spindle slide; the change from one speed to the other can be made whilst the machine is running. The arm can be revolved easily around, being supported on roller bearings. The machine is entirely self-contained, the motor being fixed on the foot of the machine; it has a large range of speeds carefully graded. The whole of the gearing on spindle slide is of steel.

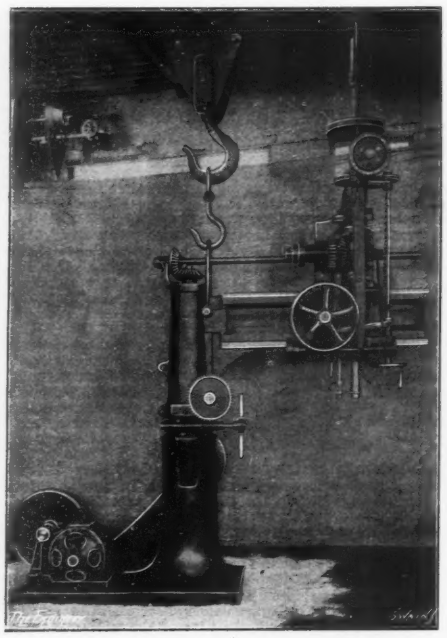


Fig. 2—PORTABLE RADIAL DRILL

Fig. 3 illustrates another form of portable electric-driven radial drilling machine, which is being built specially for girder and bridge work. The machine is arranged to fix on to large built-up girders, and drill all the top holes within its range, when it can be moved along on rollers. It is adapted for working on plates up to 5ft. wide, and when cambered into finished shape. By the use of machines of this class, a great saving is effected over hand drilling, using ordinary portable drill, or moving heavy built-up girders under fixed machines. The machine illustrated has 4ft. 6in. radius, the spindle is 2½in. diameter, and has a hand and variable self-acting feed; the gearing is steel throughout.

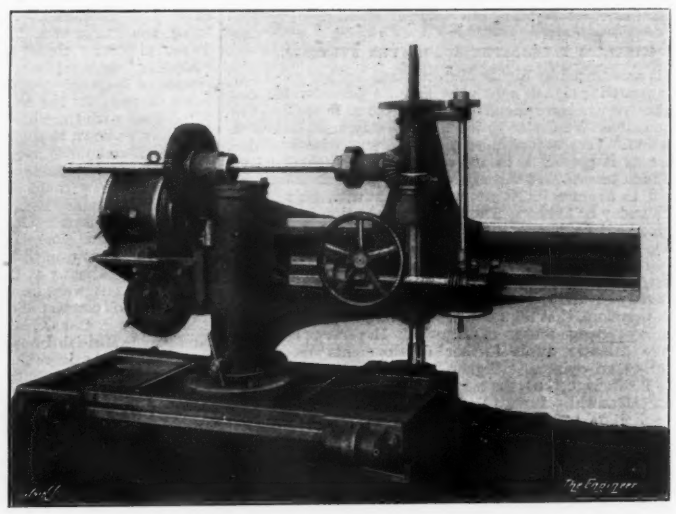


Fig. 3—PORTABLE RADIAL GIRDER DRILL

THE total length of the Madras Railway open on June 30th, 1901, was 845 miles, all on the standard—5ft. 6in.—gauge, of which only 42½ miles, between Madras and Arkonam, are double line, the remaining 802½ miles being single. In addition to the above, the Kolar Gold Fields Railway, 10 miles in length on the standard gauge, the Nilgiri Mountain Railway, 17 miles, on the metre gauge, and the North-East line—*i.e.*, the portion of the East Coast Railway made over for working purposes to this company, and now officially known on the North-East line of the Madras Railways system—507 miles, on the standard gauge, of which four miles are double line, were worked by the company, making the total length worked on June 30th 1379 miles, as against 871¼ miles in the corresponding period of 1900. The gross revenue of the Madras Railway proper in the half-year ended June 30th was £534,259, against £511,746 in the corresponding half of 1900.

DOCKYARD NOTES.

THE Isis, returned from the China station, has reached Spithead.

MORE submarine experiments have been conducted in France. Two coast defence battleships *en route* for Cherbourg, were unexpectedly attacked by night by submarines. Report says that they "were very surprised." The boats found the ships all right, but—the ships had signalled the coastguard, and had all lights out. Nor were they anticipating attack. Consequently there was little simulation of war probabilities.

SIGNOR MARCONI has, he says, succeeded in sending "wireless" messages across the Atlantic. Curiously enough, the success of wireless telegraph is, so far, the great thing against it for naval purposes. Hence the search for "screens," and other methods for isolating messages. There is little doubt, however, that ere long the problem of preventing messages being received by the enemy will be satisfactorily solved; while even now expert operators are able to judge the distance whence a message has come. This is, of course, of utility. The main necessity for wireless work lies in skilled operators, it being almost imperative that they can read by sound. No matter how faint the message, it is never wrong in sound, whereas distance rapidly affects the printing apparatus. Many so-called failures are really due to inexpert operators.

THE American naval attaché is hardly going the way to make himself popular with the Navy League. In a recent interview he has stated that the British fleet is equal to any three Powers. Opinions in "interviews" do not always amount to very much; but if the American courts popularity, he ought to be far more pessimistic.

LORD CHARLES BERESFORD returns home soon. In the *Naval and Military Record*, which is not usually wont to be sarcastic, there are this week some pretty speculations about "our only admiral," and the Admiralty's gladness to "have the benefit of this gallant admiral's experienced advice." We can imagine the frantic joy that will prevail. French comment runs:—"The Admiral Lord Charles Beresford will soon again return to England, where his voice has been the most loud of all sailors. If, therefore, the British Navy does not appreciate him, the people of France are not entirely without some sort of appreciation."

THE Temperley-Miller coaling-at-sea system is being installed at Devonport in connection with the new extension, and great things are expected in the way of time-saving. Whether the sea trials answer or not, there is no question that the apparatus has immense possibilities in many little-suspected directions. Very possibly developments in this direction may out-shadow all that has been or will be done on the water. On land, of course, none of the immense sea difficulties will be encountered.

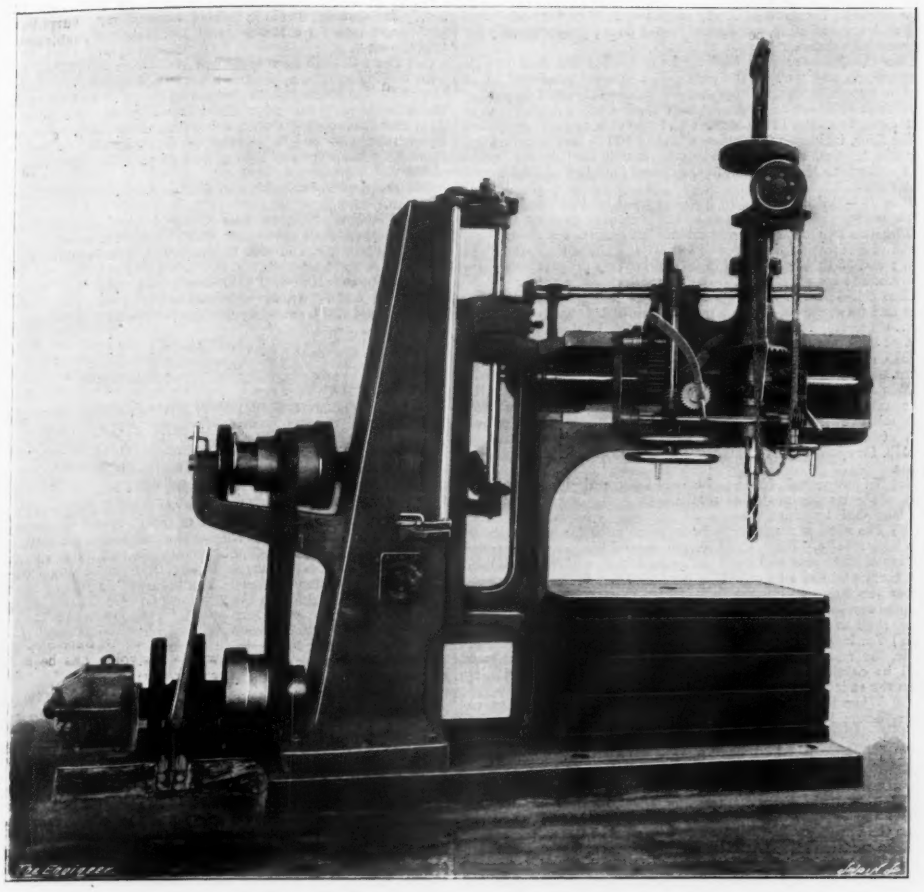
THE ALDERSHOT MOTOR WAGON TRIALS.

AFTER about a fortnight's severe tests of the running powers of the five motor wagons which were entered for the War-office trials at Aldershot, the committee on Tuesday decided to test the vehicles in a manner which could leave no possible doubt as to their abilities to "go anywhere where an ordinary cart can go." The competitors were taken to the Long Valley and were indulged in a sort of steeplechase. The Foden vehicle, which had so far done all that could reasonably be expected of it, found in the jumping of a ditch an effectual bar to further progress, its front wheels and axle being wrenched away from the body. The other vehicles were not required to perform the same feat, and three of them, namely, the two Thornycroft wagons and the Straker lorry, completed the tests, but the Daimler oil engine wagon had the misfortune to damage its motors, and had to be towed off the ground by means of a traction engine. In a final and still more severe test, the three vehicles mentioned were run over about a quarter of a mile of deep mud with their trailers and full load. In these tests the Straker lorry burst a steam pipe; one of the Thornycroft vehicles, by the aid of spuds bolted on the wheels, succeeded in making the trip successfully, but the heavier machine sank in the mud down to its axles, whence it eventually wound itself out by means of its own winding drum and steel hawser which had been secured to a traction engine.

6 FT. RADIAL DRILLING AND TAPPING MACHINE

MR. W. ASQUITH, HALIFAX, ENGINEER

(*For description see page* 634)



A NEW GREASE SEPARATOR.

ALL users of boilers are alive to the importance of removing from the feed-water all traces of oil or grease. There are numerous devices for bringing this about, and among the newest of these is that made by Joseph Wright and Co., of Tipton. This apparatus is made in several forms, either vertical or horizontal. We recently had the opportunity of seeing one of the latter variety in the yard of Wright and Co.'s works. It was employed in purifying from grease the exhaust steam from one of the engines driving the works which had been condensed in an evaporative condenser, and in softening the make-up water which was being obtained from the supply mains. As will be seen from the accompanying engravings—Figs. 1 and 2—the apparatus consists of a plate iron tank some 13ft. 6in. long, by 4ft. high and 4ft. wide. It is divided into six compartments by transverse plates, but only in one case does one of these plates extend quite from top to bottom of the tank. In the other instances the plates alternately start from either the top or the bottom, and do not quite reach the bottom or the top, as the case may be. The result of this is that the passage of the water through the tank is made as long as possible. To describe the apparatus more particularly, the greasy water enters by the inlet to the left-hand side. In some cases, where the amount of grease is excessive, it is advisable to let this greasy water pass first through a settling tank with baffles, where a considerable quantity of the grease separates out by floating, and can be removed by skimming or otherwise. There is always grease remaining almost, as it were, in solution in the water, and this a lengthened period of stagnation would not entirely remove. In the particular apparatus which we saw at work the purification from grease, and the softening of the hardened make-up feed-water, is brought about by the addition of a solution of quicklime, and a combination of precipitation and filtration. A lime-supply cistern will be observed at the left-hand side of the tank. The supply of water to this—and hence its output of lime-water—is regulated by means of a valve, and the lime-water supply is always proportioned to the amount of water passing through to the apparatus to be cleansed. This fact will be evident when it is observed that there is an automatic valve actuated by a float and weighted lever arrangement, the float working in a small circular vessel communicating with the main tank, and that the supply pipe to the lime cistern is a branch taken from the delivery side of this valve. It is obvious that the action of the automatic valve is governed by the height of liquid in the main tank.

When the apparatus is at work, the greasy water, with its admixture of lime water—graduated according to requirements—is led down the central pipe to the chamber at the bottom of filter No. 1. In this chamber a certain amount of sludge is deposited, and there are hand holes and sludge cocks for its removal, as is the case also with the other compartments of the tank. The liquid then percolates up through filter No. 1, and finds its way by a pipe into precipitating chamber No. 1. This pipe connects with another pipe bringing in make-up water through an automatic valve, the delivery of the combined liquids being nearly at the bottom of the chamber. Since the overflow from filter No. 1 brings with it an excess of lime solution, the hardness of the make-up water is reduced by precipitation. In the case which we saw there was no provision made for the sulphates of lime or magnesia, nor was the make-up water itself greasy, but the makers are prepared to supply the necessary arrangements for meeting these cases, and such arrangements are readily imagined. From No. 1 precipitating chamber the liqu flows successively, as indicated by the arrows, through precipitating chambers 2, 3, and 4, further precipitation taking place as it progresses. Finally, it percolates upwards through filter No. 2, and runs away through the overflow purified of grease, softened and clear—in fact, ready for use in the boilers.

We give below a copy of tests made by the makers of the hard make-up water and the purified water as it issues from the apparatus. Make-up feed:—Hardness before boiling, 21·11 grains per gallon; hardness after boiling, 5·3 grains per gallon, showing 5·3 grains per gallon permanent hardness. The purified water, consisting of the condensed water and the make-up feed-water after treatment, gave the following test:—Hardness before boiling, 1·95 grains per gallon; hardness after boiling, 1·95 grains per gallon; grease absent. According to these tests, the whole of the temporary hardness had been eliminated and the permanent hardness reduced to 1·95 grains per gallon by dilution with condensed steam; and, further, the whole of the grease was extracted. This is, in fact, what is claimed by the makers, who further claim to eliminate the permanent hardness by means of soda. The apparatus which we illustrate has a capacity of 2000 gallons per hour.

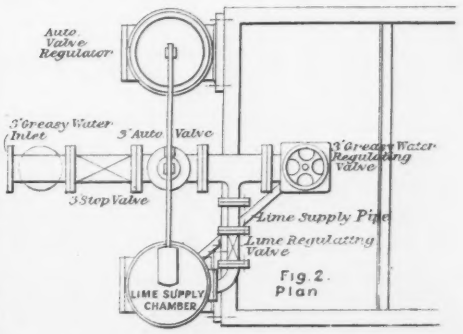


Fig. 2. Plan

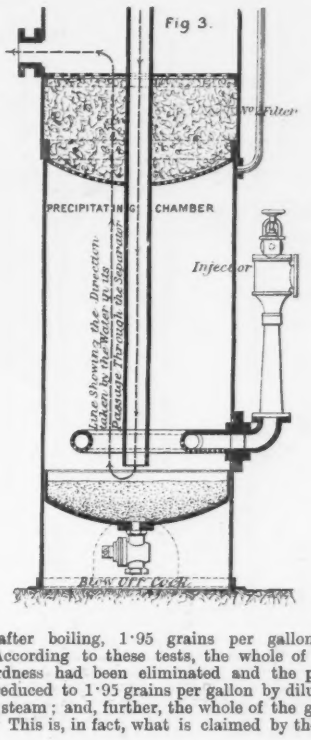


Fig 3.

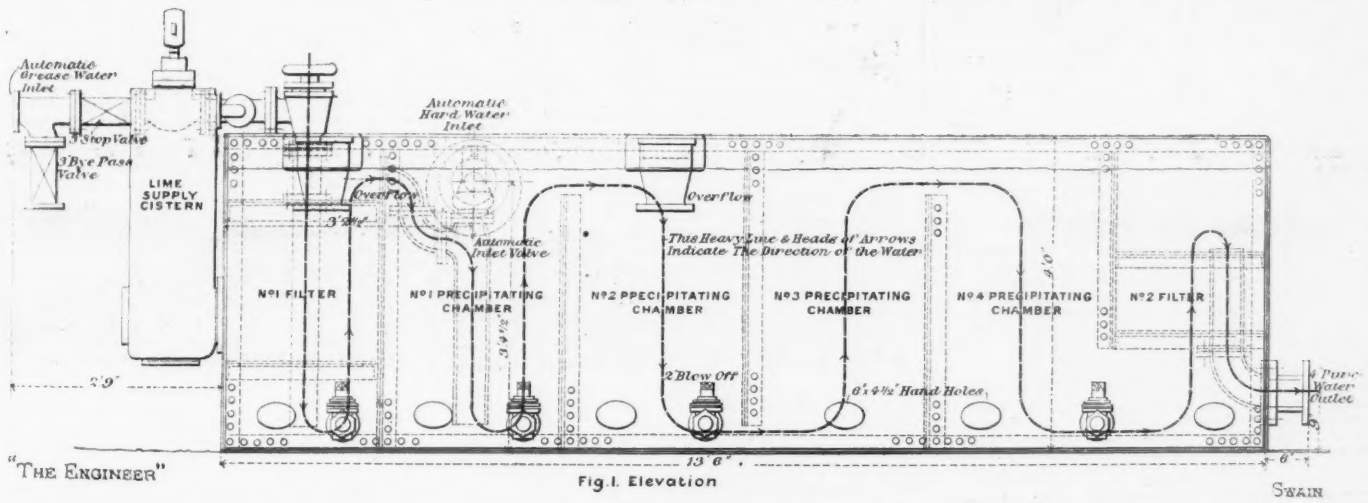


Fig. I. Elevation

"THE ENGINEER" SWAIN

with holes in its lower side. Steam can be sent into this by means of an injector, and the rate of precipitation of the suspended matter hastened. The water then flows upward through the filter and away at the overflow. This apparatus is said to give equally good results, and we are informed that the consumption of steam is not large—certainly not more than a few pounds weight per 1000 gallons.

AMERICAN BRIDGE SPECIFICATIONS.

AT this moment, when so much attention is being given to bridge contracts, the following specifications possess much interest:—

GENERAL SPECIFICATIONS FOR STEEL HIGHWAY BRIDGES.

These specifications were prepared primarily for the instruction and guidance of the engineering and operating departments of the American Bridge Company. They are intended to conform to the best modern practice, and will ensure first-class designs, material, and workmanship, consistent with economy, specifying only requirements which are essential to produce first-class work, such as can be done at a minimum cost by using modern methods in a shop equipped with modern tools.

If not otherwise stated by the purchaser, the designs will be prepared in accordance with these specifications. The material and workmanship specified therein have been adopted as the standard of the American Bridge Company.

GENERAL DESCRIPTION.

(1) Bridges under these specifications are divided into six classes, viz.:—Class A, for city traffic; Class B, for suburban or interurban traffic with heavy electric cars; Class C, for country roads with light electric cars or heavy highway traffic; Class D, for country roads with ordinary highway traffic; Class E 1, for heavy electric street railways only; Class E 2, for light electric street railways only.

(2) All structures to be of rolled steel, except the flooring and wheel guards of Classes A, B, C, E 1 and E 2, and the stringers, flooring, and wheel guards of Class D, which may be of timber. Cast iron or cast steel will be permitted only in machinery of movable bridges, and in special cases for shoes and bearings.

(3) The following types of bridges are recommended:—For spans up to 25ft., rolled beams; for spans from 25ft. to 40ft., rolled beams or plate girders; for spans from 40ft. to 80ft., plate or lattice girders; for spans from 80ft. to 140ft., lattice girders: for spans over 140ft., lattice girders or pin connected trusses.

(4) At an elevation of 1ft. and over above the roadway, the clear distance between trusses shall be at least 14in. greater than the width of the roadway between wheel guards.

(5) For Classes A, B, C, E 1, and E 2 the clear head room for a width of 6ft. over each track shall not be less than 15ft., for Class D not less than 12½ft. above the floor.

(6) For bridges carrying electric cars the clear width from the centre of track shall not be less than 6½ft. at a height exceeding 1ft. 6in. above the top of rails, where the tracks are straight.

(7) In determining the clearance on curves the extreme length of electric car shall be taken as 45ft., the width 8ft., and the distance between centres of trucks as 20ft., unless otherwise specified.

(8) The width between centres of trusses shall in no case be less than one-twentieth of the span between centres of end pins or shoes.

(9) A strong and suitable handrailing shall be placed at each side of the bridge, except where plate girders serve the same purpose, and be rigidly attached to the superstructure.

(10) Each bridge shall have such name plates, suitably inscribed and located, as may be required.

(11) All floor beams in through bridges shall be riveted to the main girders.

(12) Steel stringers shall preferably be riveted to the web of the floor beams. Wooden joists shall not be less than 3in. thick, shall be spaced not more than 2½ft. between centres, and shall be dapped over the seat angles or floor beams to exact level. In the latter case they shall lap by each other over the full width of the floor beam, and shall be separated ½in. for free circulation of air.

(13) For single thickness the roadway planks shall not be less than 3in. thick, nor less than one-twelfth of the distance between stringers, and shall be laid transversely with ¼in. openings.

(14) When an additional wearing surface is specified for the roadway, it shall be 1½in. thick, and the lower planks, of a minimum thickness of 2½in., shall be laid diagonally and with ½in. openings.

(15) Wheel guards of a cross-section not less than 6in. by 4in. on each side of the roadway shall be provided. They shall be blocked up from the floor plank with blocks 2in. by 6in. by 12in. long, not over 5ft. apart centre to centre, held in place by one ⅞in. bolt passing through the centre of each blocking piece and securely fastened to the stringer below. The wheel guards shall be spliced with half and half joints with 6in. lap over a blocking piece.

(16) The footwalk planks shall not be less than 2in. thick nor more than 6in. wide, spaced with ½in. openings.

(17) All plank shall be laid with the heart side down; shall have full and even bearing on and be firmly attached to the stringers.

(18) For bridges of classes A and B a solid floor, consisting of stone, asphalt, &c., on a concrete bed, is recommended. For this case the flooring will consist of buckle plates or corrugated sections, and the concrete bed shall be at least 3in. thick for the roadway and 2in. thick for the footwalk, over the highest point to be covered, not counting rivet or bolt heads.

(19) Buckle plates shall not be less than $\frac{5}{16}$in. thick for the roadway and ¼in. thick for the footwalk.

(20) For solid floor the curb holding the paving and acting as a wheel guard on each side of the roadway shall be of stone or steel projecting about 6in. above the finished paving at the gutter. The curb shall be so arranged that it can be removed and replaced when worn or injured. There shall also be a metal edging strip on each side of the footwalks to protect and hold the paving in place.

(21) Provision shall be made for drainage clear of all parts of the metal work.

(22) The floor of bridges of classes E 1 and E 2 shall consist of cross-ties not less than 6in. by 6in., spaced with openings not exceeding 6in. and securely fastened to the stringers by bolts. There shall be guard timbers not less than 6in. by 6in. on each side of each track, with their inner faces not less than 9in. from centre of rail. They shall be notched 1in. over every tie, and fastened to every fourth tie.

LOADS.

(23) In determining the weight of the structure for the purpose of calculating strains, the weight of timber shall be assumed at 4lb. per foot B.M., the weight of concrete and asphaltum at 130 lb., of paving brick at 150 lb., and of granite stone at 160 lb. per cubic foot. The rails, fastenings, splices, and guard timbers of street railway tracks, resting on cross ties, shall be assumed as weighing 100 lb. per lineal foot of track.

(24) The bridges of the different classes shall be designed to carry, in addition to their own weight and that of the floor, a moving load, either uniform or concentrated, or both, as specified below, placed so as to give the greatest strain in each part of the structure.

Class A.—City bridges.—For the floor and its supports, on street car track or on any part of the roadway, a concentrated load of 24 tons on two axles 10ft. centres and 5ft. gauge—each assumed to occupy a width of 12ft.—and upon the remaining portion of the floor, including footwalks, a load of 100 lb. per square foot.

For the trusses, for spans up to 100ft., 1800 lb. per lineal foot of each car track—assumed to occupy 12ft. in width—and 100 lb. per square foot for the remaining floor surface; for spans of 200ft. and over, 1200 lb. for each lineal foot of track and 80 lb. per square foot of floor; proportionally for intermediate spans.

Class B.—Suburban or interurban bridges.—For the floor and its supports, on any part of the roadway, a concentrated load of 12 tons on two axles 10ft. centres and 5ft. gauge—assumed to occupy a width of 12ft.—or on each street car track a concentrated load of 24 tons on two axles 10ft. centres; and upon the remaining portion of the floor, including footwalks, a load of 100 lb. per square foot. For the trusses, for spans up to 100ft., 1800 lb. per lineal foot of each car track and 80 lb. per square foot for the remaining floor surface; for spans of 200ft. and over, 1200 lb. for each lineal foot of track and 60 lb. per square foot of floor; proportionally for intermediate spans.

Class C.—Heavy country highway bridges.—For the floor and its supports, on any part of the roadway, a concentrated load of 12 tons on two axles 10ft. centres and 5ft. gauge—assumed to occupy a width of 12ft.—or on each street car track a concentrated load of 18 tons on two axles 10ft. centres; and upon the remaining portion of the floor, including footwalks, a load of 100 lb. per square foot. For the trusses, same as for class B, except load on car tracks for spans up to 100ft. will be 1200 lb., and for spans of 200ft. and over 1000 lb.

Class D.—Ordinary country highway bridges.—For the floor and its supports, a load of 80 lb. per square foot of total floor surface, or 6 tons on two axles 10ft. centres and 5ft. gauge. For the trusses, a load of 80 lb. per square foot of total floor surface for spans up to 75ft.; and 55 lb. for spans of 200ft. and over; proportionally for intermediate spans.

Class E 1.—Bridges for heavy electric street railways only.—For the floor and its supports, on each track a load of 24 tons on two axles 10ft. centres. For the trusses, a load of 1800 lb. per lineal foot of each car track for spans up to 100ft.; and a load of 1200 lb. for spans of 200ft. and over; proportionally for intermediate spans.

Class E 2.—Bridges for light electric street railways only.—For the floor and its supports, on each track a load of 18 tons on two axles 10ft. centres. For the trusses, a load of 1200 lb. per lineal foot of each car track for spans up to 100ft.; and a load of 1000 lb. for spans of 200ft. and over; proportionally for intermediate spans.

(25) To compensate for the effect of impact and vibration, 25 per cent. of the maximum strains resulting from the above-mentioned live load shall be added thereto.

(26) The wind pressure shall be assumed acting in either direction horizontally. First, at 30 lb. per square foot on the exposed surface of all trusses and the floor, as seen in elevation, in addition to a horizontal live load of 150 lb. per lineal foot of the span moving across the bridge. Secondly, at 50 lb. per square foot on the exposed surface of all trusses and the floor system. The greatest result shall be assumed in proportioning the parts.

(27) For longitudinal bracing of structures carrying street railroads, the momentum produced by suddenly stopping the train shall be considered; the coefficient of friction of wheels sliding upon the rails being assumed as 0·2.

(28) When the structure carrying a street railroad is on a curve, the additional effects due to the centrifugal force shall be considered.

PROPORTION OF PARTS.

(29) No material shall be used less than ⅛in. thick, except for lining or filling vacant places.

(30) All parts of the structure shall be so proportioned that the sum of the maximum loads, together with the impact, shall not cause the tensile strain to exceed on soft steel 15,000 lb. per square inch, on medium steel 17,000 lb. per square inch.

(31) The same limiting unit strains shall also be used for members strained by wind pressure, centrifugal force, or momentum of train, if any.

(32) Net sections must be used in all cases in calculating tension members, and in deducting rivet holes they must be taken ⅛in. larger than the size of the rivets.

(33) Pin-connected riveted tension members shall have a net section through the pin hole 25 per cent. in excess of the net section of the body of the member. The net section back of the pin hole shall be at least 0·75 of the net section through the pin hole.

(34) For compression members, these permissible strains of 15,000 lb. and 17,000 lb. per square inch shall be reduced in proportion to the ratio of the length to the least radius of gyration of the section by the following formulæ:—

$$\text{For soft steel, } p = \frac{15{,}000}{l + \frac{l^2}{13{,}500\,r^2}}$$

$$\text{For medium steel, } p = \frac{17{,}000}{l + \frac{l^2}{11{,}000\,r^2}}$$

where p = permissible working strain per square inch in compression.
l = length of pieces in inches, centre to centre of connection.
r = least radius of gyration of the section in inches.

(35) No compression member, however, shall have a length exceeding 120 times its least radius of gyration, excepting those for wind bracing, which may have a length not exceeding 140 times the least radius of gyration.

(36) The reversal of strain in members of bridges of classes A, B, C, and D need not be considered, but the members shall be proportioned for the strain giving the larger section. For bridges of classes E 1 and E 2 members subject to alternate strains of tension and compression in immediate succession—as counter stresses in web members or chords in continuous trusses—shall be so proportioned that the total sectional area is equal to the sum of areas required for each strain.

(37) In case the maximum strains due to wind, added to the maximum strains due to vertical loading—including impact—shall exceed the following limits:—On soft steel, 19,000 lb. per square inch; on medium steel, 21,000 lb. per square inch, properly reduced for compression, addition must be made to such sections until these limits are not exceeded. The permissible strains for the connections shall be increased proportionately.

(38) Should the strains be reversed in any possible case, proper provision must be made for such strains in the opposite direction.

(39) When the floor system rests directly on the top or bottom chord, the latter must be so proportioned that the algebraic sum of the strains per square inch on the outer fibre, resulting from the direct compression or tension, and three-fourths of the maximum bending moment—the chord being considered as a beam of one panel length, supported at the ends—shall not exceed the before-mentioned limiting strains in tension or compression, the proper amount of impact being added to each kind of loading.

(40) The bending moment at panel points shall be assumed equal to that in the centre; but in opposite direction.

(41) All other members which are subject to direct strain in addition to bending moment are to be similarly calculated.

(42) The shearing strain on rivets, bolts, or pins, per square inch of section, shall not exceed 11,000 lb. for soft steel, and 12,000 lb. for medium steel; and the pressure upon the bearing surface of the projected semi-intrados—diameter × thickness—of the rivet, bolt, or pin hole, shall not exceed 22,000 lb. per square inch for soft steel, and 24,000 lb. for medium steel.

(43) In field connections the number of rivets or bolts thus found shall be increased 25 per cent. if driven by hand, but 10 per cent. for rivets driven by power.

(44) The bending strain on the extreme fibre of pins shall not exceed 22,000 lb. per square inch for soft steel, and 25,000 per square inch for medium steel, when centres of bearings of the strained members are taken as the points of application of the strains.

(45) Plate girders shall be proportioned on the assumption that ⅛ of the gross area of the web is available as flange area. The compressed flange shall have the same sectional area as the tension flange; but the unsupported length of flange shall not exceed twenty times its width.

(46) In calculating shearing strains and bearing strains on web rivets of plate girders, the whole of the shear acting on the side next the abutment is to be considered as being transferred into the flange angles in a distance equal to the depth of the girder.

(47) The shearing strain in web plates shall not exceed 9000 lb. per square inch for soft steel, and 10,000 lb. per square inch for medium steel.

(48) The web shall have stiffeners riveted on both sides, with a close bearing against upper and lower flange angles at the ends and inner edges of bearing plates, and at all points of local and concentrated loads, and also, when the thickness of the web is less than $\frac{1}{70}$ of the unsupported distance between flange angles, at points throughout the length of the girder, generally not farther apart than the depth of the full web plate, with a maximum limit of 5ft.

(49) The depth of rolled beams shall in no case be less than $\frac{1}{20}$ of the span.

(50) The fibre strain on floor timber from dead and live load without impact shall not exceed 1200 lb. per square inch on yellow pine and white oak, and 1000 lb. per square inch on white pine and spruce.

(51) Wherever the live and dead load strains of bridges of classes E 1 and E 2 are of opposite character, only 70 per cent. of the dead load strain shall be considered as effective in counteracting the live load strain.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS—MANCHESTER SECTION.

INAUGURAL ADDRESS OF THE CHAIRMAN, C. H. WORDINGHAM, M. INST. C.E., M. I. MECH. E., MEMBER.*

(Concluded from page 587.)

LET us now leave this instance of the tendency to rush to extremes, and turn to another in which zeal has been allowed to outrun discretion and common sense. During the past year much commotion has been caused by the action of certain gas and water companies in the matter of possible danger from electrolysis arising from the operations of traction systems. The tendency mentioned has been evinced by both parties to the controversy. On the one hand, the gas and water companies, not satisfied with protecting their property, have sought to impose conditions which would make it commercially impossible for electrical engineers to carry out their work; while, on the other, electrical engineers have sought to repudiate responsibility altogether.

Let us look at the position impartially for a moment. Immense sums of money belonging to communities or to individual shareholders are invested in gas and water pipes laid underground, on the due maintenance of which depends the distribution of such a vital commodity as water, and of such a universally employed agent as gas. There arises a new industry which necessitates the passing of electric currents through the soil in which these pipes are laid. It is known that under certain conditions these currents may damage the valuable property already in existence. Is it to be wondered at if those responsible for such property become alarmed and seek to insure themselves against loss if damage should occur? It is urged that if the promoters of electric traction comply with certain arbitrary regulations drawn up by the Board of Trade when the state of knowledge of the subject was far less complete than now, they should be exempt from all liability for damage caused, no matter how great this may be. Is this position consistent with common fairness? The gas and water companies have, with the sanction of Parliament, expended their money in order to meet public wants. Is it just that another company, which no less, but no more, than they serves the public, should be allowed to conduct its operations in such a manner as to destroy their property. All parties should be granted the free use of the soil; but no one of them should be allowed to damage any other. Surely the only reasonable position is that the traction companies should be allowed to carry out their work in the manner sanctioned by the Board of Trade; but, if damage can be proved to have been done by them then they should bear the cost. If the traction companies have the confidence in the Board of Trade regulations, which they profess to have, they surely cannot object to this, because they will do no damage. On the other hand, if they do the damage they ought to pay for it.

It is objected that many bogus claims for ordinary corrosion will be made on the electrical companies; this may be so, but after all the onus of proof of damage lies upon the gas and water companies, and the electrical engineering profession has not hitherto proved itself lacking in either ingenuity or ability, and may safely be relied upon to take care of itself. At all events, such a consideration ought not to affect the broad question. In this controversy the disastrous effect to electric traction generally that would arise from a wholesale destruction of gas and water pipes, if such destruction should take place, seems to have been lost sight of, and I venture to think that those who point out the danger and enforce attention being paid to it now are far greater benefactors to the profession than those who vociferate that there is no danger, and urge on traction companies to what might be ultimate ruin. There is no doubt that if the danger is recognised now it can very well be avoided, for a much lower limit of drop of potential than that allowed by the Board of Trade can easily be worked to.

The second of our failings to which I have alluded is a want of foresight. A striking instance of this is the recent extensive promotion of Bills for the establishment of companies to generate electrical energy and distribute it over large districts. I do not wish for the moment to say one word upon the merits of these schemes. No doubt there are circumstances under which they may advantageously be undertaken, while in other instances it is difficult to see any justification for them. In any case, however, it is certain that they will require for their carrying out enormous quantities of plant of very large calibre. This demand is suddenly sprung upon our manufacturing firms. Can we expect they will be ready to undertake the work? Surely the better plan would have been to have provided the capital first to extend existing companies, or even establish new ones for making the plant, and then to have promoted the power companies to purchase this plant.

Looking at the subject from a commercial point of view, there is, after all, but little advantage to the electrical industry as a whole in extending the use of electrical appliance if the manufacturers cannot share in the development. I greatly fear that the course adopted will result in the orders going abroad through the unfortunate want of foresight in thus putting the cart before the horse, the labour and enterprise expended by the promoters of the schemes availing thus only to increase the prosperity of our commercial rivals. I might adduce many examples of want of foresight, but I will only allude to one other, which has particularly struck me, probably on account of my long connection with central station work. I refer to the way in which central stations are so often designed. In the early days of public supply, it was not surprising that the demand should be under-estimated, and stations be put down on a totally inadequate scale; but now, in the light of accumulated experience, it is astonishing to see the initial instalment arranged for, apparently without any regard to future increase, or if such increase be allowed for at all, it is of extremely limited extent.

Over and over again one sees designs such that it is physically im-

*Abstracted.

possible for the station to grow, and within a few years an entirely new station will have to be provided. Only a few months since, I read a description of a station concerning which it was naïvely remarked that the first instalment, in which a capacity of 1000 horse-power was allowed for, would be self-contained and independent of further extensions later on, as though this were a merit of the design! and this in face of the efforts that are being made to centralise supply even at the expense of costly long-distance mains. The two self-contained stations might almost as well have been a couple of miles apart as far as cost of management is concerned, while there would have been the benefit of such advantage as might arise from cheapening the distribution. In the same station the entrance to the repair shop was through the battery room—more want of foresight.

In concluding this address, time will only admit of my touching very briefly on one or two of the problems most likely to occupy our attention in the near future. One matter which was mooted in the very early days of the electrical industry has come into great prominence in this country during the last two years, namely, the supply of electrical energy over large areas, including small and scattered towns and villages. It does not appear, however, as though the method by which this is to be accomplished has received the consideration it deserves. In place of the problem being gone into thoroughly, it seems to have been assumed that a few enormous generating stations supplying in some cases to distances of twenty miles must be the right thing, and there has been vague talk in which coal, gas engines, gas producers, recovery plant, revision of Board of Trade regulations, and so forth have figured obscurely.

These hazy ideas, eked out with violent vituperation against everyone venturing to offer opposition, have given the impression that the difficulties have all been solved, and that it only remains to carry out the work. No explanation has been vouchsafed as to how the superposition of a number of similar demands, each with a low-load factor, is going to give as a resultant an improved load factor, or why a number of inherently unprofitable towns, when connected together by mains, the interest charges on which represent a large proportion of the total probable revenue, will be converted into a gold mine by the use of the magic words "supply in bulk."

Granted that gas-engine driving with produce gas, in conjunction with recovery plant, gives the cheapest production of electrical energy, what evidence had we that such engines will enable alternators to be run in parallel satisfactorily under working conditions, and it must be borne in mind long-distance transmission must almost of necessity be by alternating currents! Recovery plant, no doubt, gives excellent results on a 100 per cent. load factor, but its successful working requires nice adjustments among all its parts, and its capital cost is high. What will be the effect of the sudden fluctuations of demand incidental to a central station, and how will the question of cost be affected when the interest charges have to be earned in an actual station with a load factor very much below 100 per cent.? Again, is it remembered that in order to get the steam necessary for the recovery plant at a low cost, about one-fourth of the generating plant must be run by non-condensing engines, and this proportion must be preserved at all loads?

I do not say that these difficulties cannot be surmounted; I think they can, but I do say that we have heard little of the way in which they are to be met, and that, meanwhile, great mischief is wrought to less ambitious schemes by the Utopian pictures which have been presented to the public of power supplied to consumers at prices no greater than the actual cost of generation, the cost of distribution, and other essential charges being left out.

That gas engines driven with producer gas will in the future supplant steam in electrical generating stations there can be very little doubt, but their use will not be confined to stations of abnormal size, for their inherent advantages are very great. The consumption of fuel is but little more than half that of steam-driven plant, and the cleanliness and compactness of the system, coupled with the reduction of radiation and stand-by losses, render possible great strides in the direction of cheapening electrical energy, even in very small stations.

There is one method of supplying small towns and villages which has not, I think, been put forward, but which might prove a cheap and easy solution of giving to them the advantages of electrical energy. There are few towns so small as not to have a gasworks. Why should not the gas company establish producer plant and sell the gas to a locally-formed electrical company or to the local authority to use for driving electric generators. I should deprecate the gas company undertaking the electrical portion of the business themselves, partly because their staff would not have the necessary experience, partly because they would be tempted to stifle the electrical work. On the other hand, if the course I suggest were taken, each portion of the work would be looked after by those most competent to deal with it, and it would be to the interest of both parties to make the electrical undertaking succeed, for the gas company could make as great a rate of profit on the producer gas as on the ordinary lighting gas, while still enabling the electrical company to produce cheaply.

In considering this matter, it must not be forgotten that the preparation of producer gas for gas engines is by no means a simple matter, and if to this be added an ammonia recovery plant, a considerable amount of skill is required on the part of those looking after the manufacture. This skill is available in gasworks, and for this reason it would pay to put down recovery plant for producers working on a much smaller scale if the operations are carried on in connection with such works than if the plant were isolated. This extension of the gas company's make would not be at the expense of their existing business, for it is a matter of experience that the introduction of the electric light sets a higher standard of illumination, and actually increases the demand for gas for ordinary purposes, hence the introduction of the electric supply would be a clear gain to the gas company.

Gas engineers who are not wilfully blind to events must recognise that the public likes electric light and power if it can get them at a reasonable cost. It would be far wiser for them to accept the inevitable, and by joining hands with those they now look upon as enemies, participate in this new outlet for their enterprise. Electrical engineers, on their part, would do well to recognise that gas engineers can help them, and to invoke their assistance in the application of gas for the production of electrical energy. Perhaps the most important question of all at the present time is what has been so infelicitously called the "electrification of railways." That is to say, the application of electrical energy to the propulsion of ordinary railway trains over long distances.

Electric tramways have now become firmly established in this country, and there can be little doubt they will shortly become practically universal. The horse, as a rival, was easily beaten; the steam locomotive is one more difficult to displace; but the problem is already being vigorously attacked, and it looks as though, for underground railways, the battle is already won. The invasion will not, however, stop here, and already the application of electric traction to the main lines of railway is receiving serious consideration. What the result will be is by no means certain, but the present tendency to higher speeds is wholly in favour of electric traction. Though there is unquestionably yet much to be worked out as regards details, the future is distinctly promising.

This problem is in reality closely allied to the one to which I have already referred, namely, the supply of large areas of country, and the satisfactory solution of one problem will go far to help that of the other. Much depends upon the question of the pressure of supply to the motors on the trains and on whether direct or alternating currents will be the more satisfactory. These are matters that must be gone into closely in each individual case, with full data, but that a solution will be found can hardly be doubted.

I am compelled to leave untouched many matters that I might well include, but I have already trespassed far upon your patience, and I will therefore conclude with the expression of a hope that the session before us may be full of profit and interest to our members, and that many of the matters which I have so briefly touched upon will be fully discussed, and ample consideration be given to widely differing views.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FIRE-THROWING FROM LOCOMOTIVES.

SIR,—Mr. Baxter's opening paragraph loses its point when the references are made which I suggested, for of the three letters I mentioned, two were his.

Further, he should note that I have blamed the rapidly-moving gases adjacent to the jet, as well as the jet itself, as being concerned in projecting the fire, which explains his theory regarding the stepped cone. His fifth paragraph shows he has not grasped what I said of the stepped cone. If properly proportioned, the increase of vacuum would more than counterbalance any loss which the baffle plates might cause, because, as applied to a locomotive, the step cone would be more efficient than the ordinary type. Then, if a lower vacuum may be adopted, which Mr. Baxter seems to think likely, it may be attained with lower back pressure than with the usual system. Mr. Baxter is facetious about my new changes of direction, but he will surely agree that the substitution of new changes for existing ones does not necessarily mean addition to their number. The changes of direction which occur with such examples of stepped cone I have seen are not suitable in themselves for checking fire-throwing.

Mr. Baxter now tells us what the object was in attempting to ascertain the vacuum in the centre of the "vortex" blast pipe. But how does it show influence on the lower tubes? Perhaps he will be good enough to explain, for I cannot see the connection. I can tell him that the amount of gas passing up the centre pipe is about one-sixth part of the total gas ejected, but that cannot possibly affect the draught through the lower tubes appreciably. This, however, has nothing whatever to do with the reading of the "U" gauge, which is no indication of the vacuum existing in the "vortex." The effect of the rapidly-moving gases is to cause an increase of the vacuum in the connecting tube over and above that in the region where the tube end is situated. As I have repeatedly urged, when the "U" gauge readings are so influenced by the currents of gases, they are of no value, and I am glad to see that even Mr. Baxter, who has so stoutly defended them, has at last come to look upon them as "abortive," and now prefers the opinion of the man who has to work the machine. Those gauge tubes exposed to currents of higher velocity are naturally more inaccurate than those which are acted upon by slower moving currents. For this reason, pipes located at the base of or in the chimney—or in a "vortex" blast pipe—will give indications which it is a waste of time to observe. I again call upon Mr. Baxter to give us his definition of "vortex," and to show how it applies to Mr. Adams' blast pipe.

As Mr. Baxter has now thrown "U" gauges overboard, and as I have already given explanations of wear, temperature, and deposit, it is surely for him to continue his guesses as to the alleged inequality of the vacuum. I fail to see how anyone can seriously assert that there should be any difference between the vacuum at different points of the box, any more than that the surface of water should not be level. Assuming, for the sake of argument, that the amount of energy producing the vacuum is constant, the vacuum will vary according to the amount of gas flowing into the box. If we throttle the inlet so that the amount of gas flowing in is lessened, then the vacuum rises; and if the inlet is increased so that the amount of gas flowing in is greater, then the vacuum falls. If we were to open the smoke-box door it would practically disappear. This is obvious. Applying this to the present subject, we find that if any difference were observable at all, it would be that where there is most throttling, and consequently the least quantity of gas passing, the vacuum would be higher. This means that the vacuum at the bottom of the box, with the lower tubes choked, would be higher than at the top—if there were any appreciable difference at all, which I contend there is not. An equal draught through all the tubes should, if I understand Mr. Baxter rightly, lessen fire-throwing. I think I am right in saying that this equality of draught is what is aimed at in those London and North-Western engines, with the two funnels connected to the upper and lower compartments respectively, of a horizontally-divided smoke-box. I recently saw one of these engines drawing only three bogie coaches on a level road at about 60 miles an hour, and not accelerating, making a very bad display of fire-throwing.

I have studied many records of blast pipe experiments, but little or nothing is to be learnt from them, unless it is how not to do things. As I have previously stated, the most is not made out of the energy at command. One locomotive engineer asserts that little or no difference in steaming is observable if the funnel and petticoat pipe be removed—rather a biting criticism. I was extremely surprised to find that Mr. Baxter would solve the whole problem by reference to water ejectors. Where, pray, is the connection? They have but little in common with gas ejectors, as Mr. Baxter will see when he goes into the subject. Here I would recommend him to read Professor Pullen's little work on injectors; but it contains formulæ. I should like to know what Mr. Baxter expects to learn of smoke-boxes from water injectors.

Mr. Baxter mentions that I have advocated the reduction of smoke-box vacuum as a means of preventing fire-throwing; and as he continues by asking "why not with the ordinary pipe," he puts my advocacy in an entirely wrong light. What we know as smoke-box vacuum is only the average of the pulsations. Precisely what occurs is not known by anyone, and perhaps we should not be much better off if it was. We cannot, however, be very far wrong in assuming that the peaks are at least four times as high as the average, and these peaks do most of the work and the fire-lifting. The amount of gas ejected varies as the square root—Mr. Baxter must really forgive this; square root is not very difficult, and it is absolutely necessary if he is going to learn anything about the flow of gases—of the vacuum, so that the work done by these peaks is by no means in proportion to their height. For this reason a lower constant vacuum would be more efficient with less fire-lifting than a higher average with a pulsating one. For this, and other reasons, I have long seen that a fan would, theoretically, give much better results than the present intermittent blast. I say theoretically, because there are practical difficulties in the way of using a fan. In the first place, it could scarcely be driven off an axle, because the amount of air to be drawn through the fire varies according to the consumption of steam, and not according to the speed. Of course, the output of the fan could be adjusted by means of valves, or differential gearing, or other such complications, but against all this the blast has a very decided advantage to offer, in that it is automatic, adjusting itself to the amount of work being done. A fan, when dealing with heated gases is more efficient than an intermittent low-pressure steam jet; but it would be very inefficient if used in the manner Mr. Watson suggests, namely, to first heat air, and then turn it up the blast pipe. Why use air, and why heat it? The fan should be used to directly exhaust the gases and discharge them through the funnel.

As regards driving the fan, an axle drive would be objectionable for the reason I have given. The independent engine seems the most likely, but it would be more wasteful of steam than the main engine; but as its power would be a small percentage of that developed by the locomotive as a whole, perhaps this would not be felt. With an independent engine the fan could either be run at a constant speed, and the output varied to suit the prevailing conditions by means of a damper, or the speed of the engine could be varied by a stop valve. If, however, the damper or stop valve, as the case may be, is to be worked by hand, it will probably require the addition of one man to the engine crew to devote almost his whole time to controlling the draught. The output could be controlled automatically in many ways, so that only a driver and fireman would be necessary to work the engine as at present. It must not be forgotten that if the automatic device gave out the engine would be crippled, and the present automatic exhaust blast is scarcely so liable to break down, as such devices would be.

As to forced draught in closed ashpans, one must retain some amount of induced draught, sufficient to carry off the products of combustion, while overcoming the tube resistance. The pressure in the ashpan is only sufficient to drive the air through the fire, and leave as nearly as possible atmospheric pressure in the fire-box. There is no blowing out at the fire-door. The vacuum necessary in the smoke-box is very considerably reduced, as it has only to contend with the tube resistance, and not with the fuel bed as well. This plan is more efficient than the usual one, because the amount of power required to force cold air with high-pressure continuous jets is very much less than that required to propel hot gases with low-pressure intermittent jets. This plan has been tried with good results as regards draught and efficiency, and it has the advantage that there are no moving parts as with the fan.

Manchester, December 16th. ALF. COTTON.

SIR,—It may interest "Tyro" and Mr. J. C. Watson to learn that induced draught has been tried with a locomotive, but in combination with the exhaust. A Roots blower was fixed on the front of the footplate, near the smoke-box, and was driven by a small engine, steam for which was supplied from the exhaust of the high-pressure cylinders. The idea was to assist the draught, owing to the calculated exhaust pressure being so low that doubts were entertained as to whether sufficient steam could be generated from the exhaust alone when the engine was attached to a heavy train. The arrangement answered well, but the engine steamed so freely with the low exhaust that the Roots blower was done away with.

For the reason explained by Mr. Watson forced draught was not tried; there is no reason, however, why both forced and induced draught should not be used at one and the same time, having the induced in excess of the forced.

The necessity for either on a locomotive will only become apparent when it is worked as a condensing engine; even this appears to be within the range of practicability.

A very simple way to prevent fire throwing would be to have a telescopic exhaust pipe; allowing the blast orifice to come up level with the top of the chimney would entirely prevent sparks; it could then be lowered in the chimney until the draught point was reached, that would just prevent fire lifting. The chances are the driver would have to keep lowering it to its present fixed position, so as to enable the engine to steam freely.

My own practical experience with the present locomotive has been that it is only a waste of time and money to attempt to stop sparks by the use of a spark arrester. It is true, on the level some measure of success may be expected, but for grade climbing, where the exhaust is very severe, it is utterly impracticable. A combination of forced and induced draught might be a success, but this would in no way mitigate the terrific waste of steam from the exhaust. It would, however, do an immense amount of good by bringing home to engineers the great waste of steam that now takes place from all locomotives, especially so if the exhaust were allowed to escape from another direction than that of the chimney. For this reason alone its adoption is commendable. It is, however, perfectly practicable to stop fire throwing by the adoption of an improved form of compound which uses the steam up to a very low terminal pressure.

JOHN RIEKIE,
Locomotive Superintendent Indian State Railway.

Dumbreck, Glasgow, December 17th.

SIR,—My suggestion to use forced draught with a closed ash-pan, of course, implied some method of mechanical stoking to avoid the difficulty pointed out by Mr. Watson. There is no doubt but that induced draught by a fan in the smoke-box or chimney base would be the simplest. I do not, however, agree with Mr. Watson that it would be best to gear the fan from the engine axles. The speed would be too small when most blast was wanted—at starting or on a long, heavy grade, or even, indeed, to hasten the raising of steam when lighting up, or when standing or shunting. There is no doubt that if a fan is used it will be best to drive it by its own engine, just as the Westinghouse air brake pump is so driven. I was interested to see your note about trials of induced draught in Norway or Sweden, and hope yet to see some one give an account of it. Might I also suggest that one solution of the spark-throwing lies in the use of oil-burning locomotives. Is the blast at all softened in the engines burning oil on the Great Eastern Railway? TYRO.

Bewdley, December 16th.

[The same blast pipe is used for coal and oil. With the exception of Mr. Baxter's reply to Mr. Cotton, we can publish no more letters on this subject at present. Our correspondents have been repeating themselves for some time past.—ED. THE E.]

A STANDARD LOCOMOTIVE.

SIR,—The question of designing a locomotive which will become a standard for railways, and so reduce not only its first cost but the after maintenance in repairs, is really not a prodigious undertaking, if considered from a practical point of view. The most important parts of a locomotive are the boiler, the cylinders, and wheels, and it is to these attention should be given. The boiler is the most important, but now that it has reached a high standard as regards pressure and heating surface, there should be no difficulty in designing one that would be accepted as a standard, and so needs no further consideration.

Regarding the cylinders, it is not a little remarkable that most of these are still made simple, in spite of the increase in boiler pressure. One would naturally expect that some form of compounding would be compulsory, and so help towards the solution of a standard. Next comes the wheels, and it is in the standardising the diameter of these which will not unlikely play an important part in the standard design of a locomotive engine as a whole.

The ever-recurring desire of a progressive engineer is for wheels of large diameter; the wish is, no doubt, to reduce piston speed. Unfortunately, the ever-increasing demand for a more powerful engine leads to the same being cut down. Now, there appears no reason whatever why a standard wheel of 6ft., or even 7ft., should not be adopted as a standard for engines that haul the heaviest loads. All that is necessary is to increase the capacity of the cylinders so that the engine will exert the same tractive force as it did with the smaller wheel. It is, of course, obvious that cylinders of very much larger diameter will be required. Now, a simple engine on so large a scale would be out of the question, and some form of compound would be compulsory. This is exactly as it should be, and would be in keeping with high steam pressure. It is, to say the least, not practical to adopt high-pressure and not make the most of it. The question is, What is the best form of compound to adopt? The two-cylinder one is out of the running entirely. The coming system appears to be the one with four cylinders; but even this type is restricted, owing to gauge and moving dimensions, so that it is impracticable to use large high-pressure cylinders. The largest cylinder capacity can only be had by the use of three cylinders, placing the largest cylinders that moving dimensions will admit outside the frames, one on each side as high-pressure, and one low-pressure between the frames. It is

therefore practicable, by the use of three cylinders, to design a standard engine which will have the largest cylinder capacity, and which will, with a modern boiler and wheels of large diameter, be able to haul any train over a level, or fairly level, road.

For heavy grade climbing one other type would be required; the same size of boiler and cylinders, but with wheels the smallest possible, say, 42in. to 48in.

JOHN RIEKIE,
Locomotive Superintendent,
Indian State Railways.

Dumbreck, Glasgow,
December 16th.

CONSUMPTION OF COAL IN LOCOMOTIVES.

SIR,—Your practical readers are ever ready to assist the uninitiated over a difficulty, and I venture to trespass on your space with a view to obtaining some enlightenment on this subject, as to the apparent anomalies which exist in regard to the very great differences in this direction in the various classes of engines. It has been stated that the consumption of fuel is of little moment; but looked at from the point of cost the difference of a few pounds per mile more in one engine than another shows a very large item to debit at the year end, and to the lay mind it would seem that there is room for a little inquiry.

Some years ago the passenger trains from a certain station were worked by small four-coupled tender engines, having 16in. by 24in. cylinders, 5ft. 6in. wheels; the trains were of the close-coupled type of five coaches each, doing local work, daily mileage 120, on one turn four trips of 30 miles, non-stopping. The consumption then allowed for these engines was 26 lb. per mile; they nearly always came below the standard, and the men obtained the usual premium.

Some time afterwards side tank engines were sent down to work the same trains, the engines being pressed at 140 lb., cylinders 16in. by 24in., wheels 5ft. diameter, larger boiler and box than the old engines; standard of consumption raised to 28 lb. The men were never able to keep to it, varying from 30 lb. to 34 lb. During the past ten years these engines have been replaced by larger tanks, 17in. by 24in. cylinders, 5ft. 6in. wheels, still larger boiler and box, standard raised to 30 lb.; and visiting the shed some few weeks ago, after an absence of years, I was much surprised to find the coal used ranged from 37 lb. to as much as 50 lb. per mile. Inquiring of one of the old drivers, I elicited the fact that as to load of train or timing, there had been very little, if any, change—the same type of train was still in use for the branch working.

On this same railway the standard passenger engine was a four-coupled 6ft. 6in. wheels, cylinders 17in. by 24in., working at 120 lb., standard consumption 30 lb. per mile. This has given way to an engine with larger boiler and box; same size of wheel and cylinders, but working at 140 lb. Consumption allowed, however, 45 lb. How is this large difference to be explained, as at equal speeds the steam drawn from the boiler is of exactly the same volume? Again, the old standard goods engine had six wheels coupled, 5ft. 6in. diameter; cylinders, 17in. by 24in.; fuel allowed, 32 lb. to 35 lb. per mile. The engines now adopted as the standard have six coupled 5ft. 6in. wheels, 18in. by 24in. cylinders, work at 160 lb., get through no less than 70 lb. per mile, although there are still some of the old engines working in the same links, taking the same loads at the same booked speeds, which get along with half the quantity of coal.

This great difference in fuel consumption does not apply to the engines of one particular company; it is shown in those of almost all turning out the modern engine, and it would seem that some inquiry should be made as to whether it would not be more economical to use engines of the older types for certain local work, the weight of train rarely varying the year round.

Still, why there should be such a difference between engines of same wheel diameter and cylinder capacity, I am at a loss to understand. A difference of 5 lb. per mile on 150 miles per day will work out to 100 tons per year, or nearly £50 per engine, no small item.

No doubt those with a knowledge of the subject will not be as I am,

PUZZLED.

December 11th.

ELECTRIC TRAMWAY EXTENSIONS.

SIR,—I beg to draw your attention to what is evidently a mistake in the article in your current issue, on "Electric Tramway Extensions in London." It is there reported that the County Council have decided for the present not to carry the electric tramways on the Greenwich route beyond New Cross Gate, because "the headway of the four railway bridges over the roads has been found insufficient to permit of the passage under them of the type of car contemplated to be used."

Now, Sir, the stretch of road between New Cross Gate and the Greenwich terminus the road does not pass under a single bridge of any kind, but it passes over four, three of which are over railways, and one over Deptford Creek, so that you must have been misinformed as to the cause of the Council's decision.

I would, however, be pleased to know what the actual trouble was, as will many others in this district, who are looking forward to the advent of the new tramways to bring them some relief from the killing monopoly of the railway company, at whose mercy they are, for travelling in this direction. I strongly suspect that the trouble is with the railway company, and not with the bridges; for about two months ago the South-Eastern Railway Company posted at the New Cross Station bridge a notice forbidding the use of the bridge by traction engines or other heavy vehicles without first obtaining its—the railway company's—consent, stating as the reason that the bridge was only strong enough for the ordinary traffic of the district.

Now, that bridge is on the main road, and is used for all sorts of heavy traffic, and it is absurd to have a bridge in its position not strong enough for any traffic; but is it not strong enough, or is it a scheme of the railway company to prevent the electric trams being carried over it? I strongly suspect it is, for it is certain it will be a long time before the company will consent to the introduction of electric trams after its experience of the competition in the Western districts. This same New Cross bridge has been used day after day for years by traction engines and other heavy vehicles, and is still, as I personally witness. I see every day steam carts and wagons passing over it, which between their tare weight and load must weigh eight to ten tons, so it would seem as if the notice was meant for something else than what is stated.

J. J.

New Cross, S.E., December 7th.

[The responsibility for the error rests with the London County Council. The Highways Committee has, however, now given an entirely different explanation for the temporary exclusion of the New Cross Gate—Greenwich section—inasmuch as it states that, "owing to difficulties in the way of the placing of electrical conduits in the carriageway of certain bridges which carry the tramway lines over railways," it has been impossible to include this section in the present scheme. The question of surmounting the difficulty is being considered, and the Committee proposes to report again on the matter at an early date, and to recommend the Council to proceed with the reconstruction of the lines between New Cross Gate and Greenwich.—ED. THE E.]

EXPERIMENTS IN CYLINDER LUBRICATION.

SIR,—I have read with interest Mr. Bickford's letter upon this subject in your issue of 29th ult. I have given the letter the more careful attention from the fact that, from some private correspondence which I have had with Mr. Bickford, and from certain contributions of his which I have seen in your own and in other papers, I realise that he has given a very unusual amount of attention to the subject, and that consequently any remarks which he may have to make regarding it deserve the careful consideration, not only of his fellow-craftsmen, but of every oil manufacturer.

It is, therefore, peculiarly gratifying to me to find that he has a good word for one of the oils produced by the firm with which I am connected, and that pleasure is not diminished by the fact that at the same time he expresses an equally favourable opinion of an oil produced by a firm who may be opponents, although I prefer to regard them as friends. I am led to say this because, although I have not the pleasure of Mr. Wells' personal acquaintance, his name and his oils are well known to me, and I trust that he will not consider me guilty of impertinence when I say that he conducts his business on a scientific basis, and in a manner which is creditable alike to himself and to the trade with which he is connected. I daresay, however, that if Mr. Wells and I could meet we should be disposed to commiserate each other on the fact that probably neither of our firms had been represented in Mr. Bickford's trials by oils which we should have chosen to put forward had we known exactly the conditions to which they were to be exposed. I should certainly, on behalf of Price's Patent Candle Company, have put forward a different and much higher grade of natural oil, which, although also belonging to our "Belmont" group of cylinder oils, possesses a very much higher boiling point, flash point, and fire point than the sample which Mr. Bickford tested. Although it is perhaps too much to expect Mr. Bickford to repeat any of his elaborate and interesting experiments, I am sending him a sample of this extra "Belmont" cylinder oil, which is specially adapted and reserved for use with superheated steam.

I hope that Mr. Bickford will not regard me as truly hopeless when I say that I fail to grasp the direct connection between one of his tests and actual practice. I refer to the experiments in which he calls attention to the leakage of the cylinder oil through the thread at W—Fig. 2—instead of its being carried through the opening Z with the steam. This, in Mr. Bickford's opinion, points to the probability that the cylinder oil may be deposited at one end of the cylinder instead of being equally distributed all over its walls. If I am not generalising too widely from the information at my disposal, I think that I am correct in saying that it is the common practice of engineers in charge of double or triple compound engines to apply the cylinder lubricant only to the high-pressure cylinder, and to leave the second and third cylinders to be lubricated by the oil carried through by the steam. And it may be further argued in proof of the ubiquitous character of oil that in certain cases, *e.g.*, in marine engines and in refrigerators, in which it is desired to exclude oil from the boilers and from the condensers by limiting its application to the piston-rods, oil does find its way to these places, despite all precautions to the contrary. I have, however, known several cases in practice which from imperfect or ill-considered arrangements seem to confirm Mr. Bickford's contention. In one case the cylinder oil was delivered to the steam pipe at a point some distance from, and several feet below the level of the cylinder. Result—the cylinder got no oil with the steam, and had to be oiled by hand, while the oil introduced to the steam pipe found its way through the joints of the pipe.

In another case the oil was introduced to the steam pipe just outside the valve chest, but even then failed to find its way into the cylinder, and was found lodging in the steam pipe. In this case the mistake lay in the fact that the end of the lubricator pipe was flush with the inside of the steam pipe, and consequently the oil adhered to and ran down the sides of the pipe instead of being taken up by the steam.

The proper way to introduce cylinder oil is certainly with the steam, but the drop must be delivered clear of the sides of the steam pipe and fairly in the full rush of the steam, so that the steam may be thoroughly permeated with the pulverised oil and may carry it to every part of the surface of the first and of any succeeding cylinders.

The condition of a well-oiled cylinder was once aptly described to me by an engineering friend as resembling the appearance of a mirror when obscured by a film of condensed breath, and I take it that this condition can only be produced when the oil is introduced with and distributed over the sides of the cylinder by the steam.

J. VEITCH WILSON.

Belmont Works, London, S.W.,
December 12th.

LARGE MINERAL WAGONS.

SIR,—It is evident from the letters in the current issue that neither "Colliery Owner" nor "Other Side" has appreciated the first principles of the science of economical transportation. That traffic management would be decidedly inefficient which employed high capacity wagons only as an expedient to reduce the gross weight of its trains to the extent of, say, 20 per cent.; the economy so effected is only a fraction of that rendered possible by a proper utilisation of the improved stock. The extent of the saving available by reducing the cost of working individual trains is very limited; but the field for attaining great relative economy in operation by increasing the earning power of each train movement is vast, and almost unexplored hitherto in this country.

As your correspondents appear to have done me the favour of reading my former contributions to your journal, may I ask them, before entering upon further discussion, to make themselves familiar with the arguments which I have endeavoured to present in articles which have appeared in various journals, viz., on "Possible Improvements in the Economy of Railway Working," "The Transportation of Minerals by Rail," "High Capacity Rolling Stock;" and "The Capacity of Railway Wagons as Affecting the Cost of Transport" in the "Minutes of Proceedings," Institution of Mechanical Engineers, November, 1900.

Investigation of the saving to be effected by the wagon owner, apart from the carrier, necessitates the discussion, amongst other details, of current selling prices; I show no singularity in supposing that the correspondence columns of a technical journal are not a desirable medium for the exposition of the same. The results of such an investigation do, however, show that it is possible to effect a saving of 15 per cent. in capital charges and of 50 per cent. in maintenance. In times of diminished prosperity these figures may be expected to have some influence towards the co-operation of owners with the railways. If, in the meantime, the former prefer to enjoy an attitude of masterly inactivity, they need experience no surprise when they find that progressive railway managers have adopted a means of discriminating in their charges against the use of obsolete stock.

J. D. TWINBERROW.

13, Mosley-street, Newcastle-on-Tyne,
December 16th.

THE PROPULSION OF ROWING BOATS.

SIR,—Although yours is not a sporting paper, the subject matter of this letter involves mechanical principles which might with advantage and interest be discussed in your journal.

The speed of a boat is as the square of the power, or double the speed would take four times the power. It seems from the above a rowing boat would travel quicker if the power could be applied more continuously. The usual practice now is for all the oars or sculls to be dipped at the same time, which impels the boat at a maximum speed, and on the recovery of the body for the next stroke the boat slows down and moves by its own momentum, but if, say, in a double-sculling or eight-oared boat half the sculls or oars were dipped alternately, there would be continuous work being done on the water, and the boat would be propelled at one uniform speed, and the speed ought to be greater than the average speed of the boat rowed in unison. This might account for the short quick American stroke showing itself so effective, as by the quicker recovery of the body the boat is not allowed to slow down to the same extent as the one propelled by a long stroke, and it conforms more nearly to a uniform motion. By greatly exaggerating the two principles, that is, increasing the long stroke and interval of recovery and decreasing the short stroke, the advantage of the short stroke would seem more apparent. With the alternate stroke there would be nearly double the strokes per minute more than the stroke done in unison. It would increase the length of the boat on account of the clearance of the oars, but the midship section might be reduced. Crews in training might with advantage have the outriggers hinged on the body of the boat and attached to a spring, which could be made to work an indicator showing the work done in pounds pressure on each stroke of the oar.

W. J. BLAXTON.

Tucker's Library, Weymouth,
December 14th.

MOTOR CAR DESIGN.

SIR,—Of all the military motor wagons recently put on their trial at Aldershot, perhaps Thornycroft's new type is the most interesting, in that it exhibits a bold departure from the usual type. To an engineer, indeed, the placing of the boiler and engine over the driving axle seems a very natural proceeding, but we have become so accustomed to seeing them perched over the steering wheels, and the load—if there happens to be one—utilised for adhesion, that Messrs. Thornycroft's design comes with all the force of a refreshing novelty. I must confess, however, that there appears to me to be a lurking danger of the vehicle, when in an unloaded condition, rearing up on its hind wheels, to the embarrassment of the driver, and I venture, therefore, with all deference to suggest its extension backwards and the provision of a second pair of steering wheels behind the drivers, the trailing pair being connected with the leading wheels in such a way as to turn equally in an opposite direction. The vehicle would then, of course, be of greatly increased capacity, while its handiness for steering purposes would remain as before.

I may mention that this design was published by me many years ago, but so far the "horseless" idea has been too paramount to permit of the use of more than four wheels.

ALFRED J. ALLEN.

London Institution, E.C.,
December 14th.

ENGLISH *versus* GERMAN MANUFACTURERS: THE OTHER SIDE.

SIR,—I am neither an Englishman nor a German, but I order large quantities of machinery from both countries. Will you, therefore, allow me to put a few questions to Sir Richard Tangye *re* his letter in your issue of the 6th inst? (1) Why did not his agent trace the history of the engine in question before assuming that Tangyes could not supply anything so bad? (2) Why did he not prosecute the forger and pillory him, not only in his own interest but in that of Tangyes' clients, who will be made uneasy by knowing that there are spurious Tangye engines on the market, not up to the standard, and calculated to deceive even the agents? (3) Does Sir Richard Tangye seriously mean to cast a blame on German engineers in general because a rogue forged his name? I might as well call the English a nation of pickpockets because my purse was stolen at a London station.

I think I may assure Sir Richard Tangye that no decent German firm wants his name on their engines, and that it would have been wiser to bring the rogue into the German law courts, when he would have obtained full justice, without blaming honest men by implication. The question of German competition with England is much more serious than Sir Richard Tangye seems to admit, and cannot be perceptibly abated or increased by insinuations on the one hand or roguery on the other. I enclose my card.

X.

December 11th.

BOOKS RECEIVED.

The Royal Navy List Diary and Naval Hand-book for 1902. London: Witherby and Co. Price 3s. net.

Commercial French. In two parts. By W. Mansfield Poole, M.A., and Michel Becker. Part II.: With a map. London: John Murray. 1901. Price 2s. 6d.

Banking: Notes on the Origin and Development of Banking, and Lessons to be Drawn from its History. By Arthur Dougall Cochrane. London: Effingham Wilson. 1902. Price 2s. 6d.

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the Year ending June 30th, 1900. Washington: Government Printing Office. 1901.

The Construction of Foundry Patterns: An Elementary Manual for Engineering Students and Apprentices. By Herbert Aughtie, A.M.I.C.E. Manchester: The Scientific Publishing Company. 1901. Price 5s. net.

The Guide to South Africa, for the use of Tourists, Sportsmen, Invalids, and Settlers. Edited annually by A. Samler Brown and G. Gordon Brown, for the Union-Castle Mail Steamship Company, Limited. 1901-1902 edition; ninth edition. London: Sampson Low, Marston and Co., Limited. 1901. Price 2s. 6d.

THE SMITHFIELD SHOW.—In our report of this show last week by an oversight an almost self-evident error crept into our remarks on a high-speed engine exhibited by Wm. Foster and Co., Limited. After the word "rigidly" read "and efficient lubrication" instead of "and 30 brake horse-power."

THREE FAMOUS ATLANTIC LINERS.—By the breaking up of the Servia and the Alaska there disappears from the scene two of the three famous Atlantic liners whose appearances twenty years ago was rightly regarded as the opening up of a new and most important page in the history of Atlantic steaming. Now, when there is one Atlantic liner of 20,880 tons, we may smile at the excitement twenty-one years ago over the building of a steamer which proved to be a little less than 7400 tons. But who can tell what changes will be seen in the ocean liners, or perhaps the airships, of twenty-one years hence. But scarcely were the dimensions of the Servia known when it was announced that the Inman Line, which for several years before 1880 owned the City of Berlin, the largest steamer in the Atlantic mail service, was not to be outdone by the steamer which was building for the Cunard Line, but had ordered one at Barrow to be called the City of Rome, which would be larger and perhaps would be faster also than the new Cunard liner. And then a third came on the scene. The Guion Line, which held the record of the Atlantic with the Arizona, determined that it would not lightly let that record slip from it, but would order a new steamer from Fairfield, which would beat the best that either the Cunard or the Inman Line could do, and thus the order for the Alaska was given. The first beginning of the three famous steamers was not very promising. The City of Rome had her trial trip in September, 1881, and scarcely came up to the expected speed. The Servia had a breakdown in her machinery in the summer of 1881, and did not run her trial trip till November, and then there came a winter of violent storms, in which the first passages of all the three steamers were slow. But when winter passed into spring the Alaska came to the front unmistakably, and in May, 1882, broke all records on the Atlantic with a run which was the first seven days' passage between Queenstown and New York. Many changes have come in the Atlantic mail service since that date. Two of the lines which owned these pioneer steamers—the Inman and the Guion Lines—have passed away, but the fame of the three steamers which began the great step forward in size and in speed which made the speed of the Atlantic greyhounds so wonderful is not likely soon to be forgotten.—*Glasgow Weekly Mail.*

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

BEST bar makers report rather more than the average orders in hand at this late season of the year, whilst prices of marked bars have not changed for some months. There are good contracts running for best rivet and plate iron for local consumers, particularly for the rolling stock makers. It is said that these and current orders will carry makers well over the January quarterly meetings, when good shipping orders are usually placed. On the question of the marked bar basis, £8 10s., the feeling of the works is that this should be maintained, as it is said to be relatively nearly £1 a ton lower than either coal or best pig iron. Merchant bars at date are selling at £7 to £7 10s., and unmarked bars £6 10s. to £7. Hoops continue at £7 10s., rivet iron at £7 5s. to £7 10s., and angles £7 to £7 2s. 6d.

Sheets are easy this week at £7 10s. to £7 15s. for 24 w.g., galvanising qualities, and £8 to £8 5s. for 27 w.g. and 28 w.g., while corrugated galvanised—finished—sheets are quoted £11 5s. to £11 12s. 6d., delivered Liverpool for export, London prices being 5s. per ton extra. Increasing quantities of German steel are being used up in the sheet works, where the lower prices of German material offer great inducement to consumers. There is, too, about the German material an absence of difficulties which attached to the late American importations in the matter of securing regular deliveries, which is greatly in its favour.

The wrought iron tube trade is not over active, and the Tube Strip Association have reduced prices 5s. per ton, bringing the basis back to £6 15s. This action has attracted much attention on the part of the market, and it is argued that the step clearly indicates that the new Association is not so strong as it had believed itself to be. Underselling by outside firms unaffiliated with the trade organisation is voted to be the explanation of the reduction.

Pig iron values were quoted this afternoon 52s. to 52s. 6d. for Northampton forge metal, net, and 53s. for Derbyshire and Leicestershire. Foundry sorts were 57s. 6d. for No. 3 Derbyshire, 60s. No. 2, and 62s. 6d. No. 1, these prices regulating deliveries over the first two or three months of next year. Local pigs are 47s. 6d. to 48s. 6d. for common Staffordshire forge sorts, and 51s. to 53s. for medium makes. There is no question that pig iron is the healthiest section of the market at present and the most buoyant. Orders on offer for pigs are in excess of sellers' capacity to accept, and furnace owners are careless about covering their books for forward into next year. Prices generally are watched with some anxiety by consumers, negotiations for next quarter's supplies showing rates decidedly against buyers.

Part-mine pig iron from the Staffordshire furnaces is in good demand at relatively higher rates than Derbyshire or Northamptonshire metal, and the present feature in best qualities is the strong demand for all grades of foundry iron.

The steel trade in this district is well supported, notwithstanding the foreign importations, and the works are active. Bessemer billets are quoted £5 to £5 5s.; Siemens ditto, £5 5s. to £5 10s.; merchant bars, £6 15s. to £7 5s.; plates, £7 to £7 10s.; and girders, £6 to £6 5s. per ton. Steel makers in this district report that their output this year will prove to be the heaviest they have yet registered, continental and American importations of steel notwithstanding. The extra output of steel has, however, to some extent reduced that of rolled iron, prices of which have also been reduced by the low quotations for steel.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Business on the Manchester iron market remains in much the same unsatisfactory position reported last week, buying being restricted to the narrowest possible limits, and orders that are not pressing are mostly held over until after the turn of the year. On the very small business passing through, prices for current sales are steady at about late rates, but underquoting still goes on for delivery next year, which may be taken as an indication that lower prices, at any rate in some quarters, are anticipated, and there is a very general uneasy sort of feeling as to the future.

Orders giving out for pig iron are mostly for limited, hand-to-mouth parcels, with makers' quotations generally firm at last week's rates. For No. 3 foundry Lancashire makers still quote 57s. 6d., less 2½; Lincolnshire makers held a meeting last week, but decided to make no further change at present in their list basis of 50s. 6d. net; and Derbyshire brands remain nominally at about 56s. 6d. to 57s. 6d. net, delivered Manchester. Forge iron is firm at recent quotations, averaging 51s. 6d., less 2½ Lancashire, and 50s. 2d. net Lincolnshire, delivered Warrington. Lincolnshire makers are still considerably in arrear with deliveries on account of iron already sold, and are consequently under no necessity to push sales at lower rates. Lancashire makers are also short to meet the full requirements of customers, and Derbyshire iron remains practically out of the market.

The question just now which is of considerable interest is the competition of Canadian iron and its probable effect on local brands. The bounty of 2 dols. per ton allowed by the Canadian Government practically covers the cost of carriage to this country, and at the present price of local and district brands Canadian makers have a wide margin of profit which would enable them to come considerably lower in their competitive quotations if this became necessary. The average figures that have so far been current for delivery Warrington range from 49s. to 50s., which are under the prices of local brands, and further fairly large shipments of Canadian iron are on the way. Indeed, the report is that Canadian makers are prepared to send over here larger quantities than have so far been imported from the United States, and should American makers, who are practically out of the competition, determine, as is not improbable, to again secure the English market against Canadian iron, the English brands would inevitably suffer seriously under such conditions.

Middlesbrough iron, although perhaps rather steadier than of late, is still very low as compared with other brands. For prompt delivery by rail Manchester, 51s. 7d. to 51s. 10d. net would represent about average figures for good foundry qualities, with forward sellers at about 51s. 3d. to 51s. 4d. net. Eglinton is still obtainable at about 58s. net, but Glengarnock, owing to the shortness of supplies at Manchester, has stiffened up slightly, 59s. 9d. to 60s. net being now quoted, delivered docks.

Finished iron makers are but very moderately off for orders, and forges are only kept going with deliveries on account of orders secured a short time back, comparatively little new business just now being given out. The minimum basis of the associated Lancashire bar makers remains at £6 10s., and North Staffordshire bars are still quoted £6 15s., but in the open market there are outside sellers at 2s. 6d. to 5s. under the above figures. Sheets are about £8 to £8 5s., and association list rates for hoops are unchanged at £7 2s. 6d. random to £7 7s. 6d. special cut lengths delivered here, and 2s. 6d. less for shipment. Very few new orders are, however, being booked at the above figures. In the nut and bolt trade black goods are in fairly active request at steady prices, but business in bright goods is slow, with some competition to secure such orders as are giving out.

The position in the steel trade is not at all satisfactory. For hematites only a limited inquiry comes forward, and to secure business makers have to give way on recent quoted rates. Delivered Manchester, No. 3 foundry hematites are quoted 65s. up to 67s. net, but sellers in the open market are prepared to book orders at considerably less. Local-made billets remain at £4 15s. net, Warrington, and £4 16s. 3d. Manchester. For steel bars £6 10s. is a very general price at which makers are prepared to book new orders, and quotations scarcely go beyond £6 12s. 6d. Common steel plates do not average more than £6 12s. 6d., with £7 10s., less 2½, still the association list basis for boiler plates, delivered here, but sellers outside the association prepared to book at 5s. less.

A slackening of inquiry or new work giving out represents, as intimated last week, the general position throughout the engineering industries of this district. Just at present there is very little basis upon which to form any accurate opinion as to the actual condition of trade. So far, however, as an estimate can be made with respect to the future, there would seem to be a lessened pressure of new work even amongst locomotive builders and electrical engineers, who have so far been exceptionally well engaged. This does not represent any immediately approaching slackness in these branches, but rather that there is not quite so large a weight of work ahead as that which has been coming forward for some time past. In most other sections orders continue to run out with no corresponding weight of new business being secured, and in some departments a state of quietude seems imminent, whilst the textile machine trades remain in much the same depressed condition as for some time past.

Throughout the coal trade a very general and substantial improvement in the position is reported, but whether this is due to more than special conditions, which are usual at this time of the year, is perhaps doubtful. There is the customary extra buying to get in supplies of house-fire coal before the holidays, and also in the lower descriptions to cover requirements of large users for iron-making and general manufacturing purposes over the stoppages of the pits. The recent disorganisation of the railway traffic in the Midlands, which to a large extent prevented supplies of fuel being sent into Lancashire from Derbyshire is, no doubt, another important factor that is just now bringing increased pressure upon the local collieries. Whatever the cause, Lancashire collieries are all very busy, running full time, with a demand more than sufficient to take away the output.

The better qualities of round coal for house-fire purposes are in pressing request, and most collieries are filling up out of stock to meet customers' requirements, with prices firm at full rates. The demand for the lower qualities of round coal is equally active, partly on account of requirements for common house-fire consumption, but also for steam and forge purposes, and although no actually quoted advance can be reported on late rates, prices show a hardening tendency, and buyers would not be able to place orders on quite such favourable terms as a few weeks back. For good qualities of steam and forge coal 9s. is now the minimum figure at the pit, but 3d. to 6d. above this is, in some cases, being quoted where buyers are in want of quantities for prompt delivery.

Reports as to the engine fuel trade are also generally satisfactory. The better qualities of slack are in brisk request, and although it is perhaps exceptional where collieries are really short of supplies to meet the orders coming forward, a very considerable quantity of slack has been filled up out of stock during the past few weeks. Prices are strong at the full list basis, averaging 7s. to 7s. 6d. for the best qualities at the pit, and it is stated that contracts for next year have been secured on the above basis. Of the commoner sorts of slack supplies are still fairly ample, but they are much less plentiful on the market than of late, owing no doubt largely to the surplus supplies, which for some time past have been pushed on the market here, having been kept back during the past week as the result of blockage of traffic over the railways in neighbouring mining districts. For common Lancashire slack prices remain steady at about 5s. 6d. to 6s., with Derbyshire slack, although comparatively little is just now obtainable, quoted from 2s. 6d. up to 4s. at the pit mouth.

For shipment there has been a considerably increased demand during the last week or two, a good deal of which is probably due to the fact that contractors are getting all the deliveries through they possibly can before the close of the year, when the period for allowing exemptions on the coal duty expires. This, with a shortness of supplies of fuel offering at the ports, has enabled collieries to stiffen up on late rates, and 10s. 6d. to 11s. represent about average figures for steam and forge coal delivered Mersey ports.

A fair inquiry still comes forward for coke, with prices steady at recent quotations, best Lancashire foundry cokes remaining at 22s. to 24s., with best washed Lancashire furnace cokes 13s. 6d. to 14s. 6d. at the ovens.

Barrow.—There is a quiet but steady tone in the hematite pig iron market, and makers are fairly well off for orders, especially those who feed the steelworks in the district. Quotations, however, maintain the decline noted last week, and they are at 58s. 6d. to 61s. for mixed Bessemer numbers net f.o.b., while warrant iron is at 56s. 6d. net cash sellers, no buyers. The most remarkable incident of the week is that which is shown in the fact that a breakdown of the plate mill at the Barrow Steel Works has suddenly thrown several thousand additional tons of pig iron on the market, and yet in spite of this warrant stores, instead of increasing, have been diminished during the week by 1218 tons. This reduces stocks to 15,213 tons, or a reduction since the beginning of the year of 7397 tons. And yet makers have no extra stocks on hand. There are still 37 furnaces in blast, of which one is on spiegeleisen, being the same number as in blast in the corresponding week of last year.

Iron ore is a fair but not a brisk trade. Orders are steady for good sorts at 11s. 6d. net at mines. Spanish ores are quieter, but the consumption is still very large in the district, and fully half the ore used is now obtained from foreign sources.

The steel trade is busy all round, and makers have on hand orders which will keep them well employed for some time after the holidays. There are, however, less bright prospects in view, and it is possible that January will witness not only a shrinkage in orders but a lower range of prices. In the meantime prices are fairly steady, and this notwithstanding active foreign competition.

The shipbuilding and marine engineering trades show no improvement. No new orders have been booked during the week, and there is a further delay in the giving out of Admiralty contracts. The Japanese battleship Mikasa leaves Barrow for Portsmouth on December 27th.

The coal and coke trades are very quiet, but prices are firm, and deliveries are well maintained.

During last week the shipments of iron from West Coast ports reached only 4173 tons of iron and 6092 tons of steel, as compared with 7733 tons of iron and 7040 tons of steel, a decrease in iron of 3560 tons and in steel a decline of 948 tons. The total shipments this year represent 335,978 tons of iron and 442,180 tons of steel, as compared with 607,372 tons of iron and 396,909 tons of steel in the corresponding period of last year, a decrease in iron of 270,394 tons and in steel an increase of 45,271 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

IN consequence of the recent cold and stormy weather, business throughout the South Yorkshire coalfield has been very brisk. Many of the collieries have now good orders booked, and all coal brought to bank finds a ready sale. The different classes of fuel have been in large demand from all quarters to tide over Christmas, as generally the collieries will cease work for a longer period than many of the works dependent upon them for fuel. There is at present a good demand for hard coal, and much business has been arranged over next year at 9s. 6d. to 10s. per ton, although, as we have already stated, the railway companies have succeeded in renewing their contracts for coal for locomotive purposes on the basis of 9s. per ton.

The demand for house coal has been stimulated during the past week, and is still in heavy request, many collieries being pressed for supplies. The cold weather has greatly increased consumption. There is good business doing with London and Eastern Counties, merchants being anxious to obtain supplies over the holidays. Values are very firm, and practically 6d. per ton advance has been obtained on best Barnsley house, which is now quoted at 12s. 6d. to 13s. per ton. Best Silkstones are 13s. to 14s. per ton; nuts, from 11s. per ton. A heavy demand for steam coal is general, and values are firmer. The Humber ports are taking but poor tonnages for export, Hull showing a great falling off. Barnsley hards fetch 9s. to 10s. per ton. Gas coal continues in large request, more money being paid for the best qualities. There has been better business doing in engine fuel, but supplies are plentiful, and values remain unchanged, quotations being as follows:—Nuts, 8s. 6d. to 9s. 6d. per ton; screened slack, from 5s. per ton; pit slack, from 3s. per ton. The sale of coke is well sustained, prices showing a stiffening tendency.

Affairs do not improve in the heavy industrial establishments at the east end of the city. Work seems to get scarcer, and as orders are completed, very few come to take their place. The output is being continuously reduced, and the number of unemployed is being steadily increased. In the armour and several other departments where special skill is required the companies concerned are endeavouring to spread the work over as long a period as possible, so as to keep as many of their men together as they can. In ordnance and projectiles there has been a similar weakening, with very little prospect of further requirements for some time.

In respect of steel, reports are also depressing in crucible, cast steel, Bessemer, Siemens, and other similar material. Manufacturers state that they have fewer orders on their books now than they have had for several years.

One department of trade has kept up wonderfully well, and is pretty certain to be busy for months. We refer to mining and excavating tools, as well as spades, shovels, picks, hammers, and similar goods. The principal customers during the past few months have been Russia, Spain, and even Holland, where the "boycott," so freely talked of against English goods, has not been appreciably felt in Sheffield specialities. There is also a continuous call on South African account.

In the light industries of the city the season is now too late to expect any improvement in Christmas and New Year trade. The leanness of the orders given out, however, will have the effect of clearing the shelves of metropolitan and provincial merchants, and preparing the way for better trade in the New Year.

An old-established Sheffield house with an important connection in South Africa affords pleasant contrast to the general state of things in the silver and plating trades. The principal states that the demand for South Africa is at present far in excess of anything experienced for a very considerable time. It is not merely on account of the special orders required through the war, for it is found that all the old hotels are making extensions, and new hotels are springing up, while many of the officers have taken houses, more particularly at Durban, Cape Town, Port Elizabeth, and places round the coast, and it is from these sources that the fresh orders are coming. There is also considerable inquiry in the cutlery trade for the South African market, more particularly for Cape Town, Durban, Port Elizabeth, and the other places indicated. In both the cutlery and the silver trades sanguine hopes are entertained of excellent business being done the moment the war shows symptoms of coming to an early close.

NORTH OF ENGLAND.

(From our own Correspondent.)

IT may fairly be said that the market for iron and steel in this district is, on the whole, in a somewhat less despondent state than it has been hitherto this month, and while some prices have fallen, others have increased. The future of the trade is, however, so uncertain that consumers and merchants are generally chary about arranging contracts for next year's execution, and it seems to them best yet to buy from hand to mouth. However, in Cleveland pig iron, after a lengthy period of falling prices, there has been some improvement this week, partly influenced by the better shipments and the decrease in stocks in the public stores, added to which is the feeling that Cleveland pig iron has been unduly depressed in value, and that competition has really not called for the low range of prices that has prevailed of late. Certainly the Scotch custom could have been retained if the fall in prices here had been much less than it has been. A difference of 4s. to 5s. per ton would have enabled Cleveland ironmasters to deliver their iron in the Glasgow district at as low a figure as Scotch, and yet there has for most of the year been a difference of about 8s., and latterly of as much as 13s. 6d., while even now it is 12s. 3½d. It is difficult to see why Cleveland iron should have dropped in value so much more quickly than Scotch; certainly the stocks in the public warrant stores of this district have been increasing all the year, while stocks of Scotch iron have been steadily, if slowly, decreasing.

The prices of Cleveland iron have dropped so much that there is no doubt the present rates do not anything like cover the cost of production. It is calculated that it will cost most firms 46s. per ton to produce No. 3 Cleveland pig iron without loss, yet 43s. 6d. is all that can be got for it. Prices have been unduly, and it is contended unnecessarily, pressed down, and this week there has been something of a reaction, No. 3 rising from 43s. 3d. to 43s. 6d. per ton, while more business has been transacted, there being sales of No. 3, not only for early, but also for forward delivery, and the same price can be got for delivery over the first quarter of next year as is paid for prompt. The market has been influenced by the improvement in shipments, as compared with December last year, and also by the reduction in the stock of Cleveland iron in the public warrant stores this month, after a rapid and persistent increase ever since September, 1900. There continue to be more satisfactory reports from the United States, but this is counterbalanced by the bad accounts given of continental trade and prospects. Merchants who have lately been on business through the German centres of the iron and steel industries do not talk very hopefully about our prospects of business with that country next year. Nearly 550,000 tons of pig iron from Cleveland were sent in 1900; this year hardly half that quantity, and in the coming year a smaller business still is looked for.

Cleveland pig iron warrants, which were on the 2nd inst. as low as 42s. 8½d. cash—the lowest that has been known since 1898—have improved this week, until on Wednesday 43s. 5½d. cash was readily offered, and sellers quoted 43s. 6d., which was the figure to which No. 3 had been raised, and buyers would give 43s. 6d. for the latter, not only for prompt, but also for delivery over the first quarter of next year, which may be taken as an indication of their opinion that the value of pig iron is not likely to decline materially. A fair amount of buying is reported to have been done during the last few days. No. 4 foundry has been put up to 43s. 3d.

There has been some increase in the output of grey forge pig iron this week, partly on account of the bad weather, but as it has been realising more than No. 3, makers have not been particular about getting so much of the latter quality. Where it was necessary to have the furnace produce No. 3, special precautions had to be taken during the stormy weather, when the men could not charge the furnaces regularly. The blast had to be slackened, and this, while keeping up the quality, lessened the output. The supply of grey forge is small; there is none obtainable from the public warrant stores, as only No. 3 is sent in there. An instance may be given illustrating the scarcity of grey forge iron. A broker had this week to purchase 300 tons of grey forge pig iron, and had to buy from four producers before he could get his lot made up. From this it is made clear that producers are bare of stock of this quality at any rate, and manufacturers who consume it have at times great difficulty in keeping their forges going regularly, because the supplies sent to them are not equal to their requirements. Fully 43s. 6d. per ton has to be paid for grey forge, and the tendency is rather upwards. Last year this quality was a "drug" upon the market, and was 5s. 6d. per ton cheaper than No. 3; now consumers are content to pay a higher figure than for

the latter, and are glad when they can get all they need. Mottled and white iron can be got at 42s. 9d.

Hematite pig iron is declining rapidly in value, after being firm at 60s. for mixed numbers for some months. This month, already, there has been a decrease of 2s. per ton, and 58s. is readily taken. The competition for the Sheffield trade has become so keen that it has been necessary to reduce the price if the business were not to go elsewhere. Hematite forge is at 55s. Further reductions having been made in the rate of freight from Bilbao to the Tees, and the figure now being 4s. 3d.—almost the poorest on record—Rubio ore is now regularly sold at 15s. 6d. per ton, delivered at wharf in this district.

The shipments of pig iron from the Cleveland district are much better than were expected, for they not only exceed those of December last year, but also those of November this year, and that has had a good influence on the market. This month 43,704 tons have been shipped, as compared with 43,155 tons in November, 1901, and 30,198 tons in December, 1900, all to 18th. The stock of Cleveland pig iron held by Connal and Co. has been reduced 2628 tons this month, the quantity being 134,280 tons on 18th. After so long a period of increases, the decrease this month is particularly satisfactory. The stock of hematite iron remains at 300 tons, where at one time it was 138,000 tons.

The demand for manufactured iron and steel continues to fall off, and producers will probably give longer holidays this year than usual. Prices are generally well maintained, but there are now sellers of steel hoops at £6 15s., less 2½ per cent. Heavy steel rails are at £5 10s. net at works. Cast iron railway chairs have been reduced to £3 7s. 6d. net at works.

The coal trade continues very active, but shipments have been curtailed by the bad weather at sea, and some collieries have not been able to work fully on account of a lack of empty railway wagons. Prices are very firm in all branches, 12s. 6d. per ton f.o.b. being asked for best steam, 12s. 6d. to 13s. for best gas coals, and 16s. 9d. for medium furnace coke delivered at Teesside furnaces.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The pig iron market has been quiet during the week. There has not been much inquiry for iron, and speculative transactions have been hampered greatly by the want of telegraphic communication with the South. Ironfounders have been purchasing fair quantities of raw iron for delivery after the holidays, and the steel makers are also taking a little more iron, but other consumers have, as a rule, been purchasing sparingly.

Scotch warrants are quoted about 55s. 6d. cash, with very little business doing, and Cumberland hematite is idle at 56s. 9d. cash. A comparatively small business has been done in Cleveland warrants at 43s. 3d. to 43s. 3½d. cash, 43s. 3d. to 43s. 4d. for delivery in four days, 43s. 4d. seven days, and 43s. 4d. and 43s. 4½d. one month.

Merchants quote Scotch hematite 61s. 6d. for delivery at the steel works, but it is reported that somewhat less has been accepted by makers under contracts extending over the first three months of next year.

It is stated that, as the Canadian makers of pig iron have found a comparatively ready market for their products in the United States, they are not now such eager sellers for importation into this country; but, in all likelihood, merchants here will continue to take considerable supplies from the Dominion.

The export trade with the Continent in Scotch pig iron is poor, and there is little inquiry from either Germany or Holland.

The past week's shipments of Scotch pigs amounted to only 4417 tons, against 5272 in the corresponding week of last year. The arrivals of Middlesbrough pigs at Grangemouth were 7360 tons, being 989 less than in the same week of last year, and there is a total increase in these imports since the beginning of the year of no less than 162,000 tons.

Prices of Scotch makers' pigs have been steady. Govan, No. 1, is scarce and not quoted; No. 3, at Glasgow, 53s.; Carnbroe, No. 1, 56s. 6d.; No. 3, 53s.; Clyde, No. 1, 66s.; No. 3, 56s.; Gartsherrie, No. 1, 66s. 6d.; No. 3, 56s. 6d.; Calder, No. 1, not quoted; No. 3, 57s.; Summerlee, No. 1, 70s.; No. 3, 57s. 6d.; Langloan, No. 1, 70s.; No. 3, 59s.; Coltness, No. 1, 70s. 6d.; No. 3, 58s.; Glengarnock, at Ardrossan, No. 1, 65s.; No. 3, 55s.; Eglinton, at Ardrossan or Troon, No. 1, 56s.; No. 3, 53s.; Dalmellington, at Ayr, No. 1, 56s. 6d.; No. 3, 53s. 6d.; Shotts, at Leith, No. 1, 69s. 6d.; No. 3, 57s. 6d.; Carron, at Grangemouth, No. 1, 67s. 6d.; No. 3, 57s. 6d. per ton.

There are 83 furnaces in blast in Scotland, compared with 81 this time last year, and of the total 47 are producing hematite, 34 ordinary, and two basic iron.

The stock of pig iron in Glasgow warrant stores again shows some increase, but this has not been so considerable as to have any material influence on the state of the market.

It may be thought worthy of note that 100 tons of Scotch-made hematite have just been shipped to Canada by William Dixon, Limited.

There is a little more animation in the foundry trades, and steel makers report rather better inquiries; but the demand for finished iron is slow.

In the export branch of the coal trade there has been considerably less business. The past week's coal shipments from Scottish ports were 174,854 tons, compared with 190,113 in the preceding week, and 181,795 in the same week of last year. It is on the West Coast chiefly that the decrease has occurred; indeed, there has been a slight increase from the Fife ports, and those on the south side of the Firth of Forth show only a small decrease. The home demand has been good for most qualities, and the prices of all sorts of coal are quoted without material change.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The storms of late have materially upset the coal trade at all Welsh ports, and last week there was considerable blocking here and there at dock sidings. This week, with lessened gales, arrivals of tonnage have improved the situation, and the drop of 3d., and even of 6d. in some qualities of coal, promises to be soon recovered. Best seconds, it will be seen, are very close in price to best steam, and this is always a fair indication of an upward, instead of a downward, market.

At Swansea mid-week a great falling off was admitted in coal exports, and in those of fuel. Anthracite little altered. Cardiff quotations mid-week were as follows:—Best steam coal, 16s. 3d. to 16s. 6d.; seconds, 15s. 9d. to 16s.; best drys, 16s. 3d.; seconds, 15s. 3d. to 15s. 9d.; best steam smalls, 11s.; seconds, 10s. to 10s. 6d.; other kinds from 9s. 6d. It will be noticed that small steam keeps up well. Sales, I hear, at 11s. have been effected for delivery into the New Year. Monmouthshire coal also keeps up well, and 15s. 9d. to 16s. is quoted freely for Cardiff shipment; seconds, 14s. 6d. to 15s. 6d.; best households, 16s. 6d. to 17s. 6d.; No. 3 Rhondda, 16s. to 16s. 3d.; brush, 13s. 3d. to 13s. 6d.; small, 11s. to 11s. 3d.; No. 2 Rhondda, 14s. to 14s. 3d.; through and through, 11s. to 11s. 3d.; small, 8s. 6d. to 9s. Patent fuel remains at its old figures, 14s. 6d. to 15s. Coke continues on the up grade, furnace realising 18s. 6d. to 19s. 6d.; foundry, 21s. 6d. to 22s. 6d.; and special, 26s.

Swansea coalowners are indefatigable in proving the superiority of their anthracite to that of the Americans'. A sample was obtained lately from France and subjected to a rigid analysis, with the result of proving beyond question their contention to be right. But America, I may add, is also a large buyer of Welsh anthracite. I give this week quotations issued by the Exchange of the various qualities of this class of coal, which, it will be seen, as regards best, command high figures. Anthracite, best malting, 27s. 6d. net; seconds, 23s. 6d.; big vein, 21s. 6d. to 22s.; red vein, 18s.; machine-made cobbles, 24s. 6d.; nuts, 7s. 6d.; rough peas, 14s. 6d.; fine peas, all machine made, 11s. 6d.; rubbly culm, 6s.; duff, 3s. 3d. to 3s. 6d.; steam coal, 16s. 9d. to 17s. 3d.; seconds, 16s. 3d. to 16s. 9d.; bunkers, 12s. to 12s. 6d.; small, 9s. Bituminous coal: No. 3 Rhondda, 16s. 9d.; No. 2, 15s. 6d., all f.o.b. Swansea, cash 30 days, less 2½. Patent fuel, 14s. to 14s. 3d. Pitwood, 19s. to 19s. 6d. Coke, 19s. to 21s.

Colliers are to have four days' holiday at Christmas, so there is reasonable expectation this week of an active state of things at all parts. Up to mid-week the leading features at Cardiff were numerous clearances, chiefly under 2000 tons. Great damage has been caused by the storms, and repairers, at Cardiff and Barry, have been especially busy.

Barry and Sully are to benefit, I hear, from new industries.

It is being claimed for Llanelly, on the testimony of a mining expert, that a large and undeveloped coalfield exists, equal to the best Aberdare coal. It has taken a long time to make the discovery, which well-wishers for the prosperity of the port hope may be true; but the future greatness of Llanelly unquestionably lies in the fact that it is contiguous to the finest known anthracite coalfields, which will come into fuller development as the steam coal area declines. Llanelly, in common with the Swansea tin-plate district, is anticipatory of the new market for its manufactures in South Africa, when the war is ended. At present there is a good deal of industrial activity there, and make is being worked off rapidly. In the Swansea Valley the steel trade is rather quiet. Foreign bars are coming in freely, also to Newport, Mon.; Lysaght being the consignee of a large cargo of steel billets from Antwerp.

The leading Bessemer works have been busy with bars, sheets, and with rails to Buenos Ayres. Trade fairly good.

Application has been made by the Taff Vale Railway Company for an extension of time with respect to their statement of action against the Amalgamated Society, and this, I hear, has been granted.

Various actions are pending, and threaten to come to the front in the New Year. One is by Cardiff shipowners against coalowners and exporters for delay in loading, taking the colliers stop days as a holiday. The idea is to make a test case, and take it to the House of Lords if necessary. Then there is the action of coalowners, against the Federation and miners' agents, for directing the colliers to abstain from work, without having had legal permission to do so.

It was stated on 'Change, Swansea, this week, that misleading quotations of tin-plates have been given in some trade journals, buyers, prices, and not sellers' being tabulated. In the matter of foreign bars it is admitted, not only that large quantities are coming in, but that consignments may be expected for a time in the New Year. The price is about 15s. less than home make. Tin-plate manufacturers readily admit that the foreign are not so good, but appear inclined to give them a trial. Outsiders say that this course will not be unattended with risk. If the result should be inferior plates, customers may object, or certainly not buy under a reduction that would not improve matters. The great importance of the tin-plate industry at present necessitates extreme care in its administration. Latest returns show that there are 330 mills in Wales and adjoining counties, and 19,000 operatives.

In the Swansea Valley the demand for bars is greater than the supply. The Morriston Tin-plate Company has had large consignments of foreign bars. The tin-plate make last week was 66,730 boxes, but on account of the storms only 43,842 boxes were despatched. Active operations are going on in all industries at Briton Ferry. The patent fuel works put up for sale did not reach the reserve. Cambrian coke works are very busy. No further news is to hand respecting the steel works amalgamation, but a local contemporary records the visit of Mr. E. Windsor Richards and Mr. Keen to Cyfarthfa.

Mr. Windsor Richards' connection with the iron works of Wales has been from his youth. He was born at Dowlais, where his father was engineer. Removing to Rhymney, the father, while engaged in the construction of a furnace, met with his death. The son, after a sound education, filled responsible positions at the principal works in Monmouthshire, then in Yorkshire.

The closing prices in iron, steel, tin-plates, &c., are as follows, and may be accepted as the latest to be issued for some time, or until after the holidays:—

Glasgow pig iron warrants, 56s. 3d. cash, up 1s.; Middlesbrough, No. 3, 43s. 3½d., up 1s.; hematite warrants, 56s. 6½d. to 56s. 6d. for mixed numbers; Welsh bars, £6 2s. 6d. to £6 5s.; sheet iron, £8 to £8 5s.; steel rails, heavy, £5 to £5 5s.; light, £6 5s. to £7 5s.; steel sheets, £8 2s. 6d. to £8 7s. 6d.; sheet iron, £8 to £8 5s.; Bessemer steel tin-plate bars, £4 17s. 6d.; Siemens best, £5. Tin-plates: Bessemer steel cokes, 13s. to 13s. 3d.; Siemens coke finish, 13s. 3d. to 13s. 6d.; ternes, per double box, 28 by 20 C., 26s. 6d., 27s., to 28s.; best charcoal, 14s. 6d. to 15s. 6d.; big sheets, 6ft. by 3ft. by 30 g., per ton, f.o.t., £10 15s. to £10 17s. 6d.; finished black plate, £10 10s. to £10 12s. 6d. Block tin, £110 10s. to £104 5s. Spelter, £17. Copper, Chili bars, £50. Lead, £10 15s.

Iron ore at Newport and Cardiff:—Rubio, 14s. 3d.; Tafna, 15s. 3d. to 15s. 6d.; Almeria, 14s. 6d. Pitwood at same ports, 17s. per ton ex ship.

The Electric Lighting Committee, Cardiff, have accepted the tender of the British Insulated Wire Company for the supply of cables, £12,656 4s. 2d.

It is reported that in the last few months 20,000 tons of German steel have been sold in the Midlands.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

A further decrease in consumption is noticeable in most branches of the iron industry over here, and an abatement in activity was likewise perceptible in all trades, with the exception of the railway departments, which continue to be satisfactorily occupied. Crude iron has lost nothing of its former dulness, orders coming forward only very slowly, and malleable iron, too, is extremely depressed, the business done upon the week having been of the most limited description. There have again been reductions agreed upon in the Silesian districts, and during the next few weeks the position of prices will, in all probability, be worse than it is now, as the feeling of distrust with regard to the future is increasing.

Foundry pig has been meeting with a fairly good request, M. 55 to 62 p.t. being quoted, and for forge pig, which continues languid and depressed, M. 58 p.t. is officially quoted. Also for Bessemer the present list price is M. 58 p.t., and for basic M. 57 p.t., while spiegeleisen fetches M. 93 p.t., free at works.

There has been next to no business done in girders lately, though manufacturers have shown their willingness to go down on M. 100 p.t., but stocks are well filled and the stagnation in the building line prevents dealers from clearing them, moreover the outlook is so dull that it would require an uncommon amount of enterprising spirit on the part of dealers and manufacturers if they felt inclined, just now, to place any larger orders. The majority of wagon, and locomotive shops are in a satisfactory condition and the New Year is likely to bring them further orders of weight for the State railways.

A slight improvement was felt on the coal market in Germany last week, deliveries in house coal having been heavy, and even engine fuel has been in steady request. The Government pits of the Saar district produced in November of present year 746,390 t.; during the same month last year output was 772,339 t., consumption being 762,526 t.; while in November of present year 759,290 t. were consumed.

A perfectly hopeless condition prevails on the iron market in Austria-Hungary; any price almost is accepted now. Official reductions have taken place for plates, girders, and light section rails, and though the quotations for bars have not been reduced, both manufacturers and dealers would not hesitate to grant heavy concessions if there should be occasion for doing so; until now, however, consumers have not shown the slightest inclination to test the willingness of producers, next to no business has been done upon the week, and it may be months before anything like a normal trade is again transacted in Austria-Hungary.

The situation, generally, of the Belgian iron and steel market is reported to be very weak, and employment at the various shops has been decreasing, only the railway and engineering trades remain for the present well occupied. German competition is as keen as ever, and fairly successful, the prices asked being often lower than what the Belgian works note. At a tendering for 1000 t. girders for Holland, a German firm offered at 95f. p.t.; another heavy lot was offered at 100f. f.o.b. Antwerp, while the Belgian producers do not care to sell at less than 105f. p.t., and for inland consumption they even quote 122f. to 125f. p.t. In other articles of manufactured iron the tendency likewise is fluctuating and often depressed in consequence of foreign competition; latest tenderings have shown the willingness of the Belgian ironmasters to reduce their prices to the utmost in order to obtain work, and the official quotations given below must, therefore, be regarded as nominal, buyers finding no difficulty in getting their orders accepted at less.

Merchant bars No. 2, for home consumption, 127f.; the same for export, 122f.; iron plates, for inland, 137f.; and for export, 132f.; plates in basic, home consumption, 142f.; for export, 137f. Siemens-Martin plates, 152f. for inland, and 147f. for export, all per ton.

The Belgian coal market remains firm, the continued strong demand for house coal and heavy deliveries to France having reduced stocks considerably. Especially in the Mons district stocks are very low, and if the general condition of the iron industry was less depressed, Fleim coal would most likely meet with an advance. Best sorts of engine coal are quoted 14f. to 16f. p.t., and dry sorts fetch 9f. p.t., while house coal is very firm at 20f. to 33f. p.t. Coke realises 17f. p.t. for home consumption. For next year's deliveries in coke to the Minette districts the coke convention intends to quote 19f. p.t. During the first ten months of present year 2,353,517 t. coal have been imported to Belgium, against 2,835,741 t. in the corresponding period last year; export in coal from Belgium was 3,821,057 t. this year, and 4,332,938 t. last year. Import in coke during the period from January to October of present year was 131,868 t., against 244,646 t. last year. Export in coke was 693,265 t., against 907,570 t. last year. In October alone import in coal amounted on 327,715 t., against 349,290 t. in October, 1900; import in coke was 9919 t., against 25,566 t. in October last year; export in coal was 433,364 t. for October of present year, against 514,158 t. last year: and in coke 67,054 t. were exported, against 84,214 t. in October, 1900.

French ironmasters are booking few orders, the tendency all round being somewhat dull. A moderately good activity is being maintained at most works however, only forward contracts are exceedingly scarce, and there is also a want of stiffness in quotations noticeable for most sorts of iron.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

Steam coal very firm, and stems are well filled. House coal unaltered, the rough weather preventing the arrival of sailing vessels. Prices firm. Exports for week ending 14th:—Coal: Foreign, 53,281 tons; coastwise, 10,543 tons. Imports for week ending 17th:—Pig iron, 1070 tons; steel billets, 1461 tons; sulphur pyrites, 1030 tons; manganese, 1500 tons; cement, 480 tons; pitwood, 7562 loads.

Coal: Best steam, 15s. 9d. to 16s.; seconds, 15s.; house coal, best, 17s.; dock screenings, 10s.; colliery small, 9s. to 9s. 6d. Iron ore: Rubio, 14s. 9d.; Tafna, 15s. 6d. Steel: Rails, heavy sections, £5 to £5 5s.; light ditto, £6 5s. to £7 f.o.b.; Bessemer steel tin-plate bars, £4 17s. 6d.; Siemens steel tin-plate bars, £5, all delivered in the district, cash. Tin-plates: Bessemer steel coke, 13s. to 13s. 3d.; Siemens, coke finish, 13s. 3d. to 13s. 6d., nominal. Pitwood, 17s. 6d. to 17s. 9d., ex ship. London Exchange telegrams: Copper, £50; Straits tin, £109 5s. Freights quiet.

Light Railways Act, 1896.—The Board of Trade have recently confirmed Orders authorising the construction of light railways in the rural district of Halesowen, in the county of Worcester; amending the Amesbury and Military Camp Light Railway Order, 1898; authorising the construction of a light railway in the county of Essex to join the proposed Elsenham, Thaxted, and Bardfield Light Railway with the Colne Valley and Halstead Railway; authorising the construction of a light railway in the county of Somerset, from Bridgwater to Nether Stowey and Stogursey.

The Yorkshire College Engineering Society.—Mr. A. O. Allen, B.Sc., read a paper to the members of this Society on December 9th, taking for his subject "The Exact Measurement of Length." He stated that the most accurate measurement attained by engineers was not sufficiently accurate for the physicist, who was not content to measure to one-millionth of an inch; and proceeded to show how, by means of optical instruments, very much more exact measures had been obtained. A discussion followed the paper, in which Professor Goodman brought forward some interesting points.

Fog Signals at Sea.—The report of the Trinity House Fog Signal Committee on experiments conducted at the Isle of Wight has been issued as a Blue-book. It says in these trials the siren has proved to be the most effective sound producer for fog signal purposes throughout the arc to be guarded, and under all the conditions of wind and weather experienced. The curious phenomenon of the silent area is referred to, and instances are recorded where on approaching a sound signal station suddenly, the sound, without apparent reason, is lost until quite close to the station. Professor Tyndall attributes the occurrence to the sound waves reflected from the surface of the sea when smooth interfering with the direct waves proceeding from the sound-producing instrument. Such interference, for a certain distance, causes an area of silence, or greatly diminished sound. As it is quite possible that it might exist in quiet foggy weather, the use of the lead should be made.

Royal Meteorological Society.—The Hon. Rollo Russell read a paper before the last meeting of the Royal Meteorological Society, entitled "Further Observations and Conclusions in Relation to Atmospheric Transparency." For a number of years past he had made daily observations on the clearness of the atmosphere at Haslemere, Surrey, and in the paper he gave the results of the same. The principal conclusions derived from these observations are:—Haze and fog are commonly caused by the mixture of currents at different temperatures. These currents may be local or general, high or low. Thick haze or fog not dependent on differing currents is rare, but differing currents frequently come into contact without producing haze or fog, and fairly clear weather under opposite currents is not uncommon. A fog may generally be taken *ipso facto* as evidence of the existence in the neighbourhood of a conflict of currents, and prevalent fog or haze commonly signifies that a different wind exists at a high level from that on the surface or at a slight elevation. The production of fog or haze by mixing currents depends chiefly on differences in their temperature. Broadly-extended westerly winds with westerly upper currents are the clearest, and visibility may reach the highest figures during their prevalence, whether they are dry or nearly saturated. Easterly and north winds are the most hazy, owing to the ordinary upper current from the west being seldom displaced by them, and to the mixture of these masses of air of different temperatures. When, as an exception, east and north winds are clear, it may be presumed, without direct evidence, that the upper current coincides with them in direction. In winter, therefore, unusual clearness in these winds often signifies a long spell of frost.

ALMANACS, CALENDARS, &c.

WE have received from the London office of the *Sydney Morning Herald* its annual mail time-tables, which contain the whole of the service between Europe and Australasia, with cable rates and other useful information, carefully condensed into a small compass, rendering them very convenient for the pocket. Copies may be had gratis upon application to 40, King-street, Cheapside, E.C.

WE have received from Messrs. Norton and Gregory, of Westminster Palace-gardens, sample prints made by their new black line photo-printing process. The lines are dead black on an entirely white ground, and the prints possess the advantage that erasures and additions can be made just as with a drawing on paper, so that they can barely be detected. Indeed, it is difficult in some instances to tell the prints from drawings. We understand that this firm does not supply the paper itself, but that it undertakes the printing from customers' tracings.

THE 1902 edition of the popular little workshop companion, Calvert's Mechanics' Almanac, has made its appearance. The publication has now attained its twenty-ninth year, and contains just the information which its title would lead the reader to expect, in addition to matter of more general interest. To the artisan who finds little leisure for study much of the reading contained will be found instructive, even if the compiler has not always a very clear manner of conveying his meaning. Much of the information with which the seventy pages are filled will be found very familiar to the reader of engineering papers.

AMONG the first contributions to our file of annual publications, we have received from George Cradock and Co., Wakefield, a wall calendar for 1902 of the monthly tear-off pattern, on which the dates are printed in large legible type, suitable for large offices in which there is ample wall space. Wall calendars of this pattern have also come to hand from Dickson and Mann, Limited, Bathville Steel Works, Armadale, Scotland, and the Rugby Portland Cement Company. The latter is of the firm's usual geological pattern. The former is a neat production, which has one slight defect, namely, that the dates are printed too closely together and tend to confusion. Otherwise no fault can be found with it.

LAUNCHES AND TRIAL TRIPS.

IRIS, steamship; built by, Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of, Mr. Carl Konow; dimensions, 244ft., 36ft., by 19ft.; engines, triple-expansion, 17½in., 29in., 48in., by 33in., pressure 175 lb. per square inch; launch, November 28th.

FERNLEY, steamship; built by, Wm. Gray and Co., Limited; to the order of, Mr. W. R. Rea, of Belfast; dimensions, 352ft., 49ft. 6in., by 28ft. 3in.; engines, triple-expansion, 25½in., 40½in., 67in., by 45in., pressure 160 lb.; constructed by, Central Marine Engine Company; performance was satisfactory; trial trip, December 9th.

SANTA FE, steel screw steamer; built by, C. S. Swan and Hunter, Limited; to the order of, Hamburg South American Steamship Company; dimensions, 403ft., 47ft. 9in., by 30ft.; to carry, deadweight of 7000 tons; engines, triple-expansion, 25½in., 43in., and 74in., by 48in., pressure 200 lb.; constructed by, Wallsend Slipway and Engineering Company, Limited; launch, December 11th.

SLOTERDYK, steel screw steamer; built by, Furness, Withy and Co., Limited, Hartlepool; to the order of, the Holland America Line, Rotterdam; dimensions, 413ft. long; measurement capacity, 13,000 tons; engines, triple-expansion, 25in., 46in., 77in., by 46in., pressure 180 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, December 11th.

PUTNEY BRIDGE, steel screw steamer; built by, Wm. Gray and Co., Limited; to the order of, the Bridge Shipping Company, London; dimensions, 341ft., 47ft., 27ft. 4in.; engines, triple-expansion, 25½in., 40½in., and 67in., by 45in.; pressure 180 lb.; constructed by, Central Marine Engine Works of builders; average speed 12 knots; trial trip, December 12th.

CATALOGUES.

GARRARD MANUFACTURING COMPANY, Limited, Ryland-street, Birmingham. 1902 Blue-book of cycle chain gearing and tributary mechanism, special tools, &c.—The little book is neatly got up.

CHARLES D. PHILLIPS, Emlyn Works, Newport.—This is a little pamphlet entitled "Where the Emlyn Specialities Come From." These include mortar mills, saw benches, hauling engines, cranes, friction hoists, &c.

COCHRAN AND COMPANY, ANNAN, Limited, Annan, N.B.—Descriptive catalogue of patent vertical multitubular boilers. The book also contains some data which will be found useful to engineers. This is the first catalogue issued from the company's new works, and is generally satisfactory.

TRADE AND BUSINESS ANNOUNCEMENTS.

THE International Sleeping Car and European Express Trains Company informs intending passengers to the Riviera, Egypt, Italy, Spain, Portugal, Germany, Turkey, Russia, Trans-Siberia, and the Far East, that it has moved into its new buildings, No. 20, Cockspur-street.

WE have received from the Roads Improvement Association a copy of an important memorandum which has been addressed to the President of the Local Government Board. It is claimed that the adoption of the reforms proposed would go a long way to abate the congestion of traffic and of population in urban districts and to restore prosperity to the rural districts.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

4th December, 1901.

24,639. REVERSING FRICTION GEAR, J. Eagles, Darlington.
24,640. MOUNTS for the BOTTOMS of PORTMANTEAUS, J. B. Brooks and J. U. Willis, Birmingham.
24,641. WAX CANDLES, T. J. Jackson, Dublin.
24,642. RUDDER for SHIPS, F. J. Hancox and D. McLachlan, Cardiff.
24,643. STOP MOTIONS for ELEVATORS, T. W. Cook, Peterborough.
24,644. MOVING the POINTS of RAILS by ELECTRO-MAGNETS, J. Taylor and T. H. Ashworth, Lower Broughton, Lancs.
24,645. MOUTHPIECE for USE with TOBACCO PIPES, J. H. Chamberlain, W. Marsh, and J. Creassey, Nottingham.
24,646 PORTABLE or COLLAPSIBLE TENT, J. S. Miller, Glasgow.
24,647. SHAPING CRUPPER DOCKS, S. Forsyth, Walsall.
24,648. ADJUSTABLE INDICATOR for LIBRARIES, A. Cotgreave, London.
24,649. CHILD'S LEADING BELT, A. Hollingworth, Manchester.
24,650. CHAIR LINK, R. E. Morel, D. McLachlan, and F. J. Hancox, Cardiff.
24,651. GEAR CASES or COVERS of CYCLES, W. Smith, Birmingham.
24,652. TIPPING GEARS for WAGONS, J. Curtis, Sheffield.
24,653. TREATING FEATHERS, Blyth and Co., Limited, and H. D. Golding, Liverpool.
24,654. "BEATING ENGINES," E. Partington, Manchester.
24,655. UMBRELLAS and SUNSHADES, J. Watts, Manchester.
24,656. BLIND ROLLER, W. J. Fell and J. G. Elliot, Douglas, Isle of Man.
24,657. ADJUSTABLE SPANNERS, V. I. N. Williams, Manchester.
24,658. BURNING of HYDRO-CARBONS, H. T. Tanner, Birmingham.
24,659. JOINTS for SILVER WARE, H. W. Taylor, Birmingham.
24,660. TIRES, G. W. Dawes, E. F. Dawson, and A. E. Hubbard, Manchester.
24,661. LID for JUG, J. McDonald and F. Parker, Glasgow.
24,662. WINDOWS and VENTILATORS, J. Roberton, Glasgow.
24,663. HOUSEMAID'S BOX, R. F. Scotton, Southsea.
24,664. COMMUNICATION between PASSENGERS and DRIVERS of TRAINS, J. J. W. O'Kell and A. J. B. Harvey, Barrow-in-Furness.
24,665. MILK FILTRATION, E. J. Stonier, Uttoxeter, Staffs.
24,666. ELECTRIC GENERATOR, F. T. Reid and W. Shepherd, Exeter.
24,667. RAILWAY SLEEPERS, A. E. Muirhead, Glasgow.
24,668. TENNIS SCORE MARKER, R. H. Jude, Newcastle-on-Tyne.
24,669. RIDDLE-BOX EXHAUSTER, I. Girling, Leiston, Suffolk.
24,670. PICKERS for LOOMS, A. Abegg, Manchester.
24,671. SHUTTLES for WEAVING LOOMS, A. Abegg, Manchester.
24,672. MOTORS for DRIVING MACHINES, H. Schönfeld, Manchester.
24,673. SAFETY WINDOW FASTENER, G. Prior, Chatham.
24,674. METALLIC JOINTS for PIPES, R. H. Ellis, London.
24,675. CURTAIN SUSPENDERS, G. H. Alexander, London.
24,676. WASHING MACHINES, G. B. Dowswell, Ontario, Canada.
24,677. OIL MOTOR ENGINES, W. Askham, Sneinton, Nottinghamshire.
24,678. PIPE for TOBACCO SMOKING, R. Tiltman, Whitehaven.
24,679. HINGES for WINDOWS and DOORS, H. Johannsen, London.
24,680. RAILWAY TRAIN COMMUNICATIONS, P. H. G. Stone, London.
24,681. FACE and NECK GUARD for BOTTLES, J. Miller, London.
24,682. SEALING TINS, T. S. James and C. A. V. Whitaker, London.
24,683. CEMENT, G. F. Berry and J. B. Lawes and Co., Limited, London.
24,684. PROCESS for RECOVERING WASTE CARBONIC ACID GAS, G. F. Berry and J. B. Lawes and Co., Limited, London.
24,685. GARMENT SUSPENDER, B. A. L. Batchelor, London.
24,686. INCANDESCENT LAMP FITTINGS, W. C. C. Hewtayne, London.
24,687. DRIVING CENTRIFUGAL MACHINES, H. C. Turner, London.
24,688. TRIMMING-MAKING APPARATUS, H. Rosenbaum, Barmen, Germany.
24,689. HYDRAULIC CLEANSING BRUSHES, H. South, London.
24,690. ROLLERS of CALENDERS, E. R. Beck, London.
24,691. PRODUCER GAS APPARATUS, J. S. Kemp-Welch, London.
24,692. MOTOR VEHICLE UNDERFRAMES, W. A. Crowdus, London.
24,693. MOTOR VEHICLE UNDERFRAMES, W. A. Crowdus, London.
24,694. SHOE RESTS for LASTING MACHINES, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
24,695. TOOL for CUTTING LEAD SHEATHING, F. Tyers, London.
24,696. MOTOR VEHICLES, W. A. Crowdus, London.
24,697. DYEING, R. B. Rensford.—(*L. Cassella and Co., Germany.*)
24,698. BRAKES for MOTOR VEHICLES, W. A. Crowdus, London.
24,699. CARBURETTERS, J. G. Accles and F. H. de Veulle, London.
24,700. SHIFTING POINTS of TRAM LINES, A. E. Moore, London.
24,701. OPERATING TRAMWAY SWITCHES, A. E. Moore, London.
24,702. LETTER FILE, E. C. Hitch, London.
24,703. PREVENTING the ACCUMULATION of WATER, A. E. Williams, London.
24,704. ADJUSTING FURNACE DAMPERS, A. E. Williams, London.
24,705. RAILWAY TRACKS, G. le. R. de Lenchères, London.
24,706. CLUTCH MECHANISM, F. H. de Veulle and J. G. Accles, London.
24,707. STEERING MOTOR ROAD VEHICLES, W. A. Crowdus, London.
24,708. CASES, S. Cahen, London.
24,709. OVERHEAD ELECTRIC TROLLEYS, J. Coghlan, London.
24,710. GRADUATED GLASS VESSELS, F. H. Taylor, London.
24,711. CHAIR BRACE, J. J. Faulkner, London.
24,712. SEATS for OUT-DOORS, C. A. and H. Bond, London.
24,713. CHOKING COILS, S. B. Griffith and F. Biliotti, Reading.
24,714. BRAKES for WHEELED VEHICLES, F. H. de Veulle, London.
24,715. SCREW-DRIVERS, A. Friedmann, London.
24,716. SPRINGS for VEHICLES, F. H. de Veulle, London.
24,717. LIFTING JACK, F. Hutton, London.
24,718. LOCK NUTS and WASHERS, A. Milne, London.
24,719. TRIPLE CYLINDER ENGINES, P. Brotherhood, London.
24,720. RAILWAY SIGNALLING, J. P. O'Donnell, London.
24,721. GAS FIRES, R. Clayton, London.
24,722. AUTOMATIC COUPLING of VEHICLES, C. J. Baker, London.
24,723. BUCKLE-FASTENED BOOTS, E. Liebmann, Liverpool.
24,724. SEAMS of CLOTHING, M. Rothenbücher, Liverpool.
24,725. CADDIE STICKS, E. E. Roberts, Liverpool.
24,726. INTERNAL COMBUSTION ENGINES, J. G. Accles, London.
24,727. SELF-PROPELLED VEHICLES, E. L. Cooper, London.
24,728. VALVES for PNEUMATIC TIRES, H. Lucas, London.
24,729. SECURING PULLEYS to SHAFTS, J. G. Accles, London.
24,730. GUN CARRIAGES, W. L. Wise.—(*The Skodawerke Actiengesellschaft, Austria.*)
24,731. CIGARS, A. Witmond, London.
24,732. SHOW-CARDS, W. J. Worrell and S. M. Rogers, London.
24,733. STRENGTHENING APPARATUS, A. W. Urwick, London.
24,734. COATING METALS, T. C. Hamilton, London.
24,735. ADMINISTERING NASAL INHALATIONS, G. B. Ellis.—(*K. A. Lingner, Germany.*)

5th December, 1901.

24,736. WREATH BOX, W. J. Delph, Cambridge.
24,737. ELECTRIC BATTERIES, M. Sutherland and E. Marcuson, London.
24,738. DOOR CLOSING APPARATUS, W. R. and C. C. Bradford, Kingston-on-Thames.
24,739. LIFTERS, I. Rausch, Kingston-on-Thames.
24,740. BEEHIVE, F. W. L. Sladen, Ripple Court, near Dover.
24,741. HANDLES of GOLF CLUBS, B. A. Joule, Manchester.
24,742. LADIES' DRESS SUSPENDER, P. Keogh, Manchester.
24,743. DRIVING MECHANISM for BICYCLES, G. Preston, Keighley.
24,744. WRINGING, &c., MACHINES, H. C. Longsdon, Keighley.
24,745. OIL PUMPS, J. Hughes, Liverpool.
24,746. REDUCING TOOTHED GEARING, D. Horsburgh, Manchester.
24,747. LUBRICATING ENGINE SHAFTS, E. R. Royston.—(*W. Hoy, on the High Seas.*)
24,748. PENS, R. E. Raven, West Worthing.
24,749. WATER-TIGHT BOOT UPPERS, H. Mackintosh, Inverness.
24,750. PADLOCKS, H. Mills and F. J. Stringer, Wolverhampton.
24,751. HOLDING-DOWN CARVERS' TOOL, C. F. Madely, Rochdale.
24,752. FLUE, J. S. Wilson, Gateshead-on-Tyne.
24,753. HAT PEGS, M. Cook, Leeds.
24,754. DELIVERING LIQUIDS, W. Lee and W. McMurray, Glasgow.
24,755. BURGLAR ALARM, A. B. Stewart, Glasgow.
24,756. APPARATUS for MAKING PILLS, A. C. Harris, Leicester.
24,757. SAFETY-PIN, R. Nicholas, Manchester.
24,758. ELECTRIC TROLLEY PULLEY, J. Best and T. Russom, Leeds.
24,759. SEATS, G. P. Appleyard, Halifax.
24,760. ELECTRIC LAMP HOLDERS, W. Crookell, Manchester.
24,761. CENTRIFUGAL PUMPS, M. Paul, Glasgow.
24,762. CYCLE BRAKES, J. Hines, Glasgow.
24,763. RUBBER PRESERVATIVE, T. E. Truss and G. H. Moore, Chester.
24,764. WAIST BELTS, Koch and Feldmann, Manchester.
24,765. PRINTING MACHINES, T. Hooley, Manchester.
24,766. HOODS for PERAMBULATORS, C. Ashford, Birmingham.
24,767. SHIRT, J. M. Barclay, Dublin.
24,768. LOUNGE and BED, P. Bercovitz and I. Stone, London.
24,769. WITHDRAWING CORKS from BOTTLES, D. S. Campbell, Liverpool.
24,770. INGOT TONGS, J. Lister, Bridlington.
24,771. BOX KEYS for SCREW BOLTS, W. McCallum, Glasgow.
24,772. PLOUGH, W. A. Massey, Llandudno.
24,773. MOTOR, E. Chatham, Manchester.
24,774. APPARATUS for TILTING CASKS, D. S. Campbell, Liverpool.
24,775. FIRE-GRATE, J. I. Richards, Llansamlet.
24,776. JARS, C. McCallum and J. M. Campbell, Glasgow.
24,777. BAT for TABLE TENNIS, A. E. L. Slazenger, London.
24,778. SEALED VESSELS, J. Robinson and H. Gore, London.
24,779. COUPLINGS for RAILWAY WAGONS, T. Locker and J. Pilkington, London.
24,780. DECORATING CHINA, A. J. Boult.—(*O. Leproux, France.*)
24,781. NON-REFILLABLE BOTTLES, A. J. Boult.—(*H. W. Avery, United States.*)
24,782. BRAKE MECHANISM for VEHICLES, G. Kerslake, London.
24,783. HOLDER for UMBRELLAS, E. C. B. Saxby, Manchester.
24,784. GAS LAMP GLOBES, E. Böhm, London.
24,785. NURSERY APPLIANCE, K. Gaiger, London.
24,786. STEAM MOTORS, T. Clarkson, London.
24,787. PUMPS, T. Clarkson, London.
24,788. RULER, A. Kühn, London.
24,789. METAL WEDGE for WINDOWS, C. J. Watts, London.
24,790. AUTOMATIC COUPLING, A. C. Greene, London.
24,791. PROJECTILES, W. Ruegg, London.
24,792. CORSETS, J. E. Snider, London.
24,793. SPRING SEATS for CARRIAGES, W. Percival, London.
24,794. ELASTICALLY SUPPORTING SHAFTS, A. Krank, London.
24,795. ROTARY BLOWERS, W. Beecroft and T. H. Booth, London.
24,796. NUT-LOCKS for SCREW-BOLTS, R. Harrington and W. H. Fletcher, London.
24,797. ELECTRIC MOTORS, D. P. Burdon and E. F. Cavelier, London.
24,798. INSULATING BOARD, G. Kelly, London.
24,799. GOLF-PLAYING REQUISITES, O. H. Vaughton, London.
24,800. APPARATUS for HEATING LIQUIDS, J. Fliegel, London.
24,801. LOCKS, J. Hohagen, London.
24,802. COMPRESSING the PACKING MATERIAL of PIPE JOINTS, L. van Waegeninghi, London.
24,803. ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*H. W. Buck, United States.*)
24,804. ALTERNATING CURRENTS, The British Thomson-Houston Company, Limited.—(*E. M. Hewlett, United States.*)
24,805. MEASURING INSTRUMENTS, The British Thomson-Houston Company, Limited.—(*R. H. Read, United States.*)
24,806. ELECTRO-MAGNETIC SWITCHES, The British Thomson Houston Company, Limited.—(*S. E. Stewart, jun., United States.*)
24,807. ELECTRIC CONTROLLERS, The British Thomson-Houston Company, Limited.—(*F. E. Case, United States.*)
24,808. ELECTRIC CONDUCTORS, The British Thomson-Houston Company, Limited.—(*F. E. Case, United States.*)
24,809. ELECTRIC BRAKES, The British Thomson-Houston Company, Limited.—(*W. B. Potter, United States.*)
24,810. ELECTRICALY-PROPELLED VEHICLES, The British Thomson-Houston Company, Limited.—(*C. E. Holmes and F. P. Cox, United States.*)
24,811. ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*L. A. Tirrill, United States.*)
24,812. ELECTRIC RAILWAY SYSTEMS, The British Thomson-Houston Company, Limited.—(*W. B. Potter, United States.*)
24,813. HOLDFAST for EXERCISING APPARATUS, L. Elliott, London.
24,814. INSTRUMENT for SIGHTING GUNS, W. Youlten, London.
24,815. MILL for GRINDING PAINT, W. H. Cranstone, London.
24,816. ELECTRIC RAILWAYS, C. J. Kintner, London.
24,817. ROPE COUPLING, W. G. Mouat and R. Walcs, London.
24,818. MACHINE for SHAPING WOOD, C. H. Fitler, Liverpool.
24,819. GUARDS for MACHINERY, F. E. Roopr, Liverpool.
24,820. APPARATUS for OPERATING RAILWAY SWITCHES and SIGNALS, G. Bleynie and T. Ducousso, Liverpool.
24,821. BLEACHING OIL, W. P. Thompson.—(*A. N. Nielson, Newfoundland.*)
24,822. CLOSING DEVICES for FOOD VESSELS, F. Ginet, Liverpool.
24,823. MAKING BOTTLES and JARS, J. J. MacIntyre, London.
24,824 APPARATUS for WASHING COAL, Bell Brothers, Limited, and M. R. Kirby, London.
24,825. PRODUCING ELECTRIC WAVES, J. A. Fleming and Marconi's Wireless Telegraph Company, Limited, London.
24,826. SLICKS for UMBRELLAS, F. W. Chambers, London.
24,827. TOASTERS, T. Hamer, London.
24,828. SURGICAL HAND MOTORS, A. W. and H. V. Down, London.
24,829. SURGICAL OPERATION TABLES, A. W. and H. V. Down, London.
24,830. LIFTING DEVICE, Fabrik Schiller'scher Verschlüsse Actien-Gesellschaft and G. West, London.
24,831. STEAM GENERATORS, H. J. Fisher, London.
24,832. DISTILLATION of AMMONIACAL LIQUORS, G. Wilton, London.
24,833. ELASTIC TIRES, C. H. Paschke, London.
24,834. PRIMARY BATTERIES, R. Pearson, London.
24,835. COAL-BOXES, S. W. Sequeira, London.
24,836. MACHINERY for RAISING GOODS, H. S. Fox, London.
24,837. COKE OVENS, S. T. and C. H. Wellman, London.
24,838. RECOIL APPARATUS for ORDNANCE, W. L. Wise. (*Skodawerke Actiengesellschaft, Austria.*)
24,839. TELEPHONE SYSTEMS, P. Arnheim, London.
24,840. KILNS or FURNACES, H. H. Lake.—(*C. A. Schuppmann, Germany.*)
24,841. MANUFACTURE of ARTIFICIAL SANDSTONE, F. Oberschulte, London.
24,842. SYRINGE, J. J. Séguier, London.
24,843. WRAPPERS for TOILET PAPERS, J. T. Powell, London.
24,844. SMOKERS' COMPANIONS, P. H. A. Whitehouse, London.
24,845. POINT SHIFTING DEVICE, H. Haes and D. Finzi, London.
24,846. STAGE CYCLE TRACK, W. T. Cunningham, London.
24,847. MANUFACTURE of CUBE SUGAR, F. Scheibler London.
24,848. APPARATUS for UNSHIPPING BARGES, S. L. Ravier, London.
24,849. PREPARING SUET for COOKING PURPOSES, A. E. Iveson, London.
24,850. PRESSING ANIMAL FAT, A. E. Iveson, London.
24,851. HERMETICALLY-SEALED BOXES, G. Fincken, London.
24,852. TIGHTENING SCREW NUTS, E. Stauber, London.
24,853. FRAME for ROLLING FABRICS, E. Lelièvre, London.
24,854. TOY ANIMAL TEAMS, W. Britain, jun., London.
24,855. REGULATING SPRAY TEMPERATURE, A. Bulling, London.
24,856. SCOURING and REMOVING OIL from WOOL, A. Born, London.
24,857. TABLES, The Parker Joinery and Cabinet Company, Limited, and W. Jenkinson, Birmingham.

6th December, 1901.

24,858. PICTURE SUSPENDERS, C. H. Worsnop, and J. H. Barraclough, Halifax.
24,859. MOTOR TRANSMISSION GEARING, J. J. Barter, Bristol.
24,860. CIGAR, J. A. Thompson, London.
24,861. RECEPTACLE for COINS, R. Gorman and C. B. Tully, Sligo.
24,862. VERTICAL TOWER BOLT, J. W. Allen, Birkenhead.
24,863. ACTUATING MECHANISM of ARC LAMPS, C. E. Foster, London.
24,864. FURNACES, Bayliss, Jones, and Bayliss, Limited, and R. Howarth, Wolverhampton.
24,865. DRIVING GEAR of CYCLES, N. D. Levin, Dublin.
24,866. DRIVING BELT FASTENER, F. Barker and S. Atkin, Nottingham.
24,867. NUT BLANKS, Bayliss, Jones, and Bayliss, Limited, and R. Howarth, Wolverhampton.
24,868. CANDLESTICKS, A. Tovey, Bargoed, Cardiff.
24,869. ATTACHMENT for BEER ENGINE TAPS, C. Chambers, Birmingham.
24,870. VALVE TAP for BEER, C. Chambers, Birmingham.
24,871. SEALING LID STOPPERS, C. Chambers, Birmingham.
24,872. TRACES, S. Bird, W. Mason, and G. Nicklin, Birmingham.
24,873. DETACHABLE PAD for BOOTS, K. Wright, Glasgow.
24,874. POTATO DIGGERS, J. Meikle, Glasgow.
24,875. COVER for MANHOLES, J. W. and T. Whitworth, Manchester.
24,876. LOCKING MECHANISM for SEATS, T. Downes, Bristol.
24,877. RAIL-SANDING APPARATUS, G. L. Andrews and A. W. Wigram, Sunderland.
24,878. EXPLOSION ENGINES, A. Gower, London.
24,879. ANTI-VIBRATION JOINTS, F. J. Whitworth and A. J. Short, Smethwick.
24,880. DEVICE for EDUCATIONAL PURPOSES, C. W. Robbins, Leicester.
24,881. CASEMENT FASTENER, F. T. Robinson, Derby.
24,882. CASTING INGOTS for ARMOUR-PLATES, W. Beardmore, Glasgow.
24,883. BILLIARD-CUE REST, J. Barrow, Glasgow.
24,884. FURNITURE, J. Harris and F. Langley, Wrexham.
24,885. MILK and PORRIDGE SAUCEPAN, F. J. Williams, Ripon.
24,886. LOCKING MECHANISM for BUREAUS, E. Crowe, Banbury.
24,887. CLOSING ELECTRIC CIRCUITS, W. E. Burgess, Aberbeeg, Mon.
24,888. SOUND-DETERMINING INSTRUMENT, W. R. Willis, Devonport.
24,889. FEED GAUGE for PRINTING MACHINES, W. A. Guest, Ormskirk, Lancashire.
24,890. COMPOUND DRIVING BELTS, T. F. Edwards, London.
24,891. ROTARY ENGINES, A. Gosling, Hazel Grove, Cheshire.
24,892. SAFETY HOLDER for PENS, A. J. Jackson, Weaverham, Cheshire.
24,893. CONTROLLING VEHICLES, F. E. Kinsman, London.
24,894. LIFTS, W. Wright, H. W. Hobson, C. B. Carryer, and A. C. Buswell, London.

24,895. DETACHABLE UMBRELLA HANDLE, E. Jackson, London.
24,896. TUBE for POWER TRANSMISSION, G. E. Crabbe, Bristol.
24,897. DOOR and WINDOW ALARMS, F. J. Upton, London.
24,898. EVER-READY BEDSTEADS, L. Siegenberg, jun., London.
24,899. DIRECT-ACTING STEAM PUMPS, R. J. Hodges, Dunstable.
24,900. SELF-ACTING VEHICLE BRAKES, W. Jenkins, London.
24,901. DRAUGHT SCREEN for HOUSE FIRES, N. Purcell, London.
24,902. BLEACHING APPARATUS, W. T. Forbes and G. P. J. Leclercq, London.
24,903. GAS GENERATOR, O. H. Bayldon and H. E. Morriss, London.
24,904. PRODUCING HYDROCYANIC ACID, W. Feld, London.
24,905. MAKING CIGARS, F. C. M. S. Feldtmann, London.
24,906. GATES, C. A. Day.—(*L. J. Roberts, Cape Colony.*)
24,907. ENVELOPES, G. Hayes, London.
24,908. APPARATUS for DELIVERING COINS, E. Zanik, London.
24,909. BLINDS, J. Haworth, Liverpool.
24,910. STONE PAVEMENTS or ROADWAYS, J. Rousselle, Liverpool.
24,911. AIR TUBES for TIRES, H. Falconnet and M. Pérodeaud, Liverpool.
24,912. COVERS of TIRES, H. Falconnet and M. Pérodeaud. Liverpool.
24,913. TOOL-HOLDERS, P. Tschabran, Liverpool.
24,914. WHEELS, W. Williams, Liverpool.
24,915. TELESCOPES, A. A. Common, London.
24,916. SHAPING PRESS, J. and J. Siddons, Limited, and A. Malpass, London.
24,917. LOADING CARTRIDGE CASES, W. H. Groenwood and W. Breakspear, London.
24,918. DISCHARGE of FISH from SHIPS' HOLDS, The Boston Deep Sea Fishing and Ice Company, Limited, and J. Bloomfield, Londou.
24,919. GAS METERS, C. Bolz, London.
24,920. HYDROCYANIDE ACID, W. Feld, London.
24,921. BITS, W. S. Simpson, London.
24,922. TOYS, A. V. L. Dennys, London.
24,923. ARTIFICIAL STONE, G. C. F. Eoivic, London.
24,924. TIRES, C. Hind, London.
24,925. FIRING PROJECTILES, G. C. Marks.—(*A. A. Low, United States.*)
24,926. RAIL JOINTS, W. A. Moffat, London.
24,927. MACHINES for MAKING BOTTLES, C. Boucher, London.
24,928. FURNACES, O. Lindemann.—(*E. Körting, Germany.*)
24,929. FORCED MEAT-STIRRING MACHINE, M. Paulsen, London.
24,930. BICYCLES, J. G. L. Hayes and H. H. Barnett, London.
24,931. PRINTING MACHINES, C. Courmont, London.
24,932. MOWING and REAPING MACHINES, S. B. Bamford, London.
24,933. TROUSER PRESSES, W. S. Farmer, London.
24,934. CARTRIDGE PACKETS, Sir C. H. A. F. Lockhart-Ross, Bart, London.
24,935. INDIA-RUBBER DOLL MAKING, F. Kuhlemann, London.
24,936. RAILWAY CARRIAGE LOCKS, J. F. H. Collett, London.
24,937. INDUCTION MOTORS, W. Langdon-Davies and A. Soames, London.
24,938. CANS, H. Grant and Co., Limited, and G. F. Hughes, London.
24,939. CONSTRUCTION of WATCHES, C. W. Emery, London.
24,940. SECURING LOOKING-GLASSES in POSITION, C. Hopkia, London.
24,941. BEDSTEADS, R. Morgan, London.
24,942. MOTOR CARS, H. J. Fisher, London.
24,943. OVERHEAD RAILWAYS, BRIDGES, &c., G. Barker, London.
24,944. CENTRIFUGAL PUMP, A. March, London.
24,945. MANUFACTURE of JEWELLED PINS, L. Esslinger, London.
24,946. PADLOCKS, J. Mucha, London.
24,947. CABLE SYSTEM for UNLOADING SHIPS, N. Soliani, London.
24,948. SEPARABLE FLOORINGS, &c., P. B. Guilhou, London.
24,949. MILITARY BANDOLIER, W. T. and O. Thorn, London.
24,950. SEALED VESSELS, A. Parker, G. Woffendale, and H. M. Morris, London.

7th December, 1901.

24,951. PRESS for MAKING PIPES, E. W. Leigh, Stoke-on-Trent.
24,952. APPARATUS for WASHING WINDOWS, L. Byrens, Manchester.
24,953. CATCHING FLIES and INSECTS, T. McGrah, Sheffield.
24,954. MINERS' SAFETY LAMPS, L. N. Williams, Bristol.
24,955. TRAY for TURNING EGGS, W. Fleming, Glasgow.
24,956. BOTTLE STOPPERS, W. B. and F. D. Irvin and J. Baldwin, Manchester.
24,957. MILITARY SIGHTING TEACHER, W. F. W. Carstairs, Edinburgh.
24,958. TRAMCAR GUARD and BRAKE, N. Mackay, Glasgow.
24,959. GARDEN SYRINGES, W. C. G. Ludford, Birmingham.
24,960. GAS-CLEANING APPARATUS, W. J. Crossley and J. Atkinson, Manchester.
24,961. ELECTRIC TROLLEY-LINE DEVICE, A. H. Mayes, Hove, Sussex.
24,962. PACKING, &c., FELT HATS, T. Robinson, Manchester.
24,963. PLEASURE BOATS, A. I. Steel, Swansea Valley, South Wales.
24,964. APPLIANCE for BREAKING WOOD, W. Morgan, Birmingham.
24,965. FLY-CATCHERS, T. M. Tripp and H. and W. B. Jackson, Liverpool.
24,966. WAGON BRAKES, C. Smith, Hull.
24,967. BRAKE CLUTCH, A. H. Gibson and J. B. Hopkinson, Leeds.
24,968. SACK-SUSPENDING APPARATUS, S. Glover, Manchester.
24,969. BRACES for AUGER-BITS, E. S. Rose, Kingston-on-Thames.
24,970. ANCHORS, F. Joyner, Kingston-on-Thames.
24,971. OPERATION TABLES, A. W. and H. V. Down, London.
24,972. SELF-LUBRICATING ENGINES, A. Morcom, London.
24,973. GLOVES, C. E. Sims and H. J. Shepherd, Birmingham.
24,974. CARBURETTERS for MOTORS, H. N. Frenay, Birmingham.
24,975. ENGINE PACKINGS, J. Wood and J. E. Gimson, Manchester.
24,976. BIT SAVER for RAG-PULLING MACHINES, H. Knowles, Heckmondwike.
24,977. CANDLESTICK, G. H. Rowland and R. Webb, Cirencester.
24,978. READING STAND, J. B., T. W., and H. G. Tyler, Sheffield.
24,979. SPRING-BOTTOM TRAINING BASKET, H. E. Jackson, Manchester.
24,980. SUPPLYING GAS to BURNERS, J. Hodgson, Bradford.
24,981. PREVENTING PUNCTURING of PNEUMATIC TIRES, W. Cordeaux, Selby.
24,982. TUNING the PIANOFORTE, Z. Reynolds, Plymouth.
24,983. TOY SEE-SAW, M. Clarke, Blackburn.
24,984. SHIRTS, A. F. Maltby, Sidcup, Kent.
24,985. EGG POACHER, G. Edwards, London.
24,986. INCANDESCENT GAS BURNER, R. A. Blake.—(*J. Hardt, Germany.*)
24,987. ELECTRIC MACHINE, A. J. Boult.—(*N. A. Christensen, United States.*)
24,988. MOTOR VEHICLES, J. W. Adams and Humber, Limited, London.
24,989. TELEPHONE SYSTEMS, D. Macadie, London.
24,990. NAIL-MAKING MACHINES, J. Boothman, Manchester.
24,991. MOULDING MACHINE, A. J. Boult.—(*W. Lewis, United States.*)
24,992. ELECTRIC PRIMARY CELLS, A. P. T. Tully, London.
24,993. SEPARATION of SYRUP, W. T. Matheeuwissen, London.
24,994. QUICK WATER-HEATING DEVICE, J. Deschamps, London.
24,995. CARD CUTTERS for PRINTING PRESSES, W. F. Speight, London.
24,996. MOTOR VEHICLES, H. H. Lake.—(*Olds Motor Works, United States.*)
24,997. PISTOL, G. W. Goldring, London.
24,998. MANUFACTURE of CEMENT, A. Vickery, London.
24,999. HOLDERS for PHOTOGRAPHIC PLATES, A. J. Boult.—(*P. Boucher, France.*)
25,000. MECHANISM for ADVERTISING DEVICES, F. de Blanco, London.
25,001. CAISSONS for CLEANING SHIPS, R. Kaucher, London.
25,002. INHALER, J. Harrison, London.
25,003. ROTARY BEVEL SHEARS, C. J. Wangler, London.
25,004. PRINTING TELEGRAPHS, J. Moore and C. R. Steljes, London.
25,005. TRAMCARS, R. Hacking and J. Leighton, London.
25,006. SLICING MECHANISM, G. C. Marks.—(*H. C. Coleman, United States.*)
25,007. VAPORISERS, J. S. Phelps and J. E. Smith, London.
25,008. RELAYS, Siemens Bros. and Co., Limited, and A. Gordon, London.
25,009. MANUFACTURE of ACRIDINE DYESTUFFS, O. Imray.—(*Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
25,010. TRAVELLING TRUNKS, G. and A. Flitcher, Liverpool.
25,011. WALL PLATES, H. J. Haddan.—(*R. Müller, Germany.*)
25,012. PROJECTING SOUNDS, B. Krüger and M. Kirsten, London.
25,013. LIGHTING of GAS LAMPS, H. Stoltenhoff, London.
25,014. PREVENTING SPARKING when MAKING ELECTRIC CIRCUITS, &c., A. B. Rigby and E. G. Scott, London.
25,015. DEVICE for SEALING DOORS, G. L. Wilcox London.
25,016. BAND for USE with GARMENTS, L. F. Marsh, London.
25,017. LETTER-BOXES, J. F. Hoyne, London.
25,018. CORKS or STOPPERS for BOTTLES, H. A. Cox, London.
25,019. LAMPS, S. H. Webb, Leicester.
25,020. COIN-FREED GAME APPARATUS, G. W. Melven, London.
25,021. MANUFACTURING GOLF BALLS, P. W. H. Gray, London.

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25,022. ARMATURE for GENERATORS, B. Brander, Birmingham.
25,023. CANDLESTICKS, H. Trimby, Southampton.
25,024. SPEED GEAR for MOTOR CARS, G. Webb, Birmingham.
25,025. RODS for INCANDESCENT ELECTRIC LAMPS, L. S. Powell and Nernst Electric Light, Limited, London.
25,026. WAGON BRAKES, H. Pedley, Olton, Warwickshire.
25,027. RULES, E. Hitchon, Accrington.
25,028. SUPPLYING WATER to FIRE ENGINES, T. S. Forster, Newcastle-on-Tyne.
25,029. SANITARY WIRE MATTRESS, A. Partner, London.
25,030. PROTECTING TROUSERS, N. S. Sotiropulo and R. H. Binks, Manchester.
25,031. RULES and CALCULATING DEVICES, G. W. Sinclair, London.
25,032. TYPEWRITER, A. R. Buchanan, Glasgow.
25,033. FRICTION CLUTCHES and BRAKES, H. S. H. Shaw, Liverpool.
25,034. TARGETS, T. B. Ralston, Glasgow.
25,035. DUMMY TEATS, C. I. Faulkner, Clontarf, Co. Dublin.
25,036. COVERS for TRAMCAR SEATS, J. Scott, Glasgow.
25,037. PASTEURISING APPARATUS, C. Ollendorff, Berlin.
25,038. RIM, F. A. Rüther, Bordeaux.
25,039. SAFETY WATER CARRIER, H. E. Jackson, Manchester.
25,040. BRAKES for TRAMWAY CARS, W. T. Howard, London.
25,041. COMBINED FIRE ENGINE and ESCAPE, A. Jewell, London.
25,042. LOCKS, W. E. and J. H. Parkes and G. H. Burrows, Birmingham.
25,043. DRUMS or ROLLERS for CARRYING CONVEYORS, PICKER BANDS, &c., P. U. Askham and T. B. Marlow, Sheffield.
25,044. BEARINGS, T. W. Gornall, Liverpool.
25,045. GEAR for DRIVING CYCLES, J. P. Smithers, London.
25,046. REDUCING REFRACTORY ORES, H. R. Angel, London.
25,047. UNDER SLEEVE for BLOUSES, B. E. Lawrence, London.
25,048. BACKING ATTACHMENTS of HARNESS, T. H. Brigg, London.
25,049. CLEANING FLUES, J. G. B. Cooke and H. J. Bowles, London.
25,050. SHIRTS, W. G. Hargroves, London.
25,051. GAME, T. Paterson, London.
25,052. ACTIONS of PIANOFORTES, W. G. and E. Munt, London.
25,053. CUE SUSPENDER, N. Darmaros and J. A. Dann, London.
25,054. VALVES, F. Eastmead, London.
25,055. LATHES, O. Winzer, London.
25,056. PROCESS for CLEANING COAL, S. Butler, London.
25,057. CIGARETTES, F. Peters, London.
25,058. ORE CONCENTRATORS, The Wilfley Ore Concentrator Syndicate, Limited.—(*A. R. Wilfley, United States.*)
25,059. TRAVELLING WARDROBE-BASKET, A. Schwedler, London.
25,060. TEAPOT, F. Perry, London.
25,061. BOXES, C. Etzold, London.
25,062. STEAM BOILERS, J. B. Prudhon, London.
25,063. TREATMENT of TANNIN EXTRACTS, G. Klenk, London.
25,064. PHOTOGRAPHIC FLASH-LIGHT APPARATUS, E. Milner, London.
25,065. PHOTOGRAPHIC FLASH-LIGHT APPARATUS, E. Milner, London.
25,066. NEW WATERPROOF GARMENT, A. L. H. Kyle, London.
25,067. COVER for TIN, &c., VESSELS, G. W. Willis, London.
25,068. PNEUMATIC TIRE STRENGTHENER, W. H. J. White, London.
25,069. BLOTTING APPLIANCES, R. Baumert, London.
25,070. GOVERNING MOTORS, J. W. M. Brooke and J. W. Brooke and Co., Limited, London.
25,071. APPARATUS for MELTING GLUE, A. Jeffery, London.
25,072. BODY RESTS for BICYCLES, &c., J. Mitchell, London.
25,073. CAN OPENERS, W. Wyatt, Birmingham.
25,074. AUTOMATIC COUPLER for SHAFTS, E. Dodd, London.
25,075. INDICATING SPEED of VESSELS, S. J. Lawrence, London.
25,076. INSULATORS for HIGH-POTENTIAL CURRENTS, R. Gaetner, Liverpool.
25,077. LIQUID METERS, J. C. Anderson, Liverpool.
25,078. PNEUMATICALLY-OPERATED LUBRICATORS, H. Schmidt, London.
25,079. BATS, J. G. Renvoize, London.
25,080. FOUNTAIN PENS, F. C. Barnes and J. Smith, London.
25,081. TELEPHONE RECEIVER BOX, M. Sensenschmidt, London.
25,082. TREPHINES, A. Wormull, London.
25,083. MANUFACTURE of SIGNS, A. C. Amy and H. Battams, London.
25,084. CLIPS for GLASS TABLETS, A. C. Amy and H. Battams, London.
25,085. MOUNTING of SHAFTS, S. Bianchi, London.
25,086. SCENERY CLIP, C. Anderson, Swindon.
25,087. ELECTRIC GLOW LAMPS, A. J. H. Gurney and A. S. Blundell, London.
25,088. AUTOMATIC PISTOLS, T. K. North, London.
25,089. SUBSTITUTED AURAMINES, O. Imray.—(*Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
25,090. PIPES for RADIATORS, F. Windroff, London.
25,091. DISCONNECTABLE PIPE COUPLINGS, O. Ledovsky, London.
25,092. REGULATING GAS GENERATORS, A. J. Boult.—(*F. M. Hille, Germany.*)
25,093. FASTENING of BOOTS, J. A. Mann, London.
25,094. POCKET-CLOSING DEVICES for GARMENTS, J. Trimmel, J. Lohr, and L. Hahn, London.
25,095. ELECTRICAL FITTINGS, M. Churchill-Shann, London.
25,096. BOTTLE-FILLING DEVICES, C. Cisar, London.
25,097. PRINTING MACHINES, H. E. Newton.—(*R. Hoe, United States.*)
25,098. MANUFACTURE of BOOTS, J. and A. Cheaney, London.
25,099. VALVULAR ARRANGEMENT for CONTROLLING FLUIDS, The Schmidt Steam Power Parent Company, Limited, R. Webster, and J. Björnstad, London.
25,100. REDUCTION of AROMATIC NITRO-COMPOUNDS, G. W. Johnson.—(*C. F. Boehringer and Soehne, Germany.*)
25,101. SYPHONS, H. V. R. Read, London.
25,102. FORMOLATORS, H. Dussaix, London.
25,103. TRANSMITTING MOTION, J. C. Moore, London.
25,104. FURNACES, H. Schwiebus, London.
25,105. PIPE COUPLINGS, P. J. Dervin, London.
25,106. WOOD MOSAIC ART PANELS, W. J. Rockwood, London.
25,107. PIANOS, C. W. Pressley, London.
25,108. AUTOMATIC SAFETY VALVES, G. C. Marks.—(*F. B. Morrison, United States.*)
25,109. WALKING STICKS, J. P. Morgan, London.
25,110. HYDRAULIC CONTROLLING VALVES, W. Kershaw, London.
25,111. WAIST and SKIRT SUPPORTER, E. M. Adams, London.
25,112. BOTTLE, T. S. Philpott, London.
25,113. PROTECTING WATER PIPES, J. C. H. van Duyl, London.
25,114. CORK SEAL, A., G., and W. Thurgate, London.

10th December, 1901.

25,115. DUSTBIN, W. J. Green, London.
25,116. SPRINGS for SHAKING SIEVES, T. Smith, Normanton, Yorks.
25,117. LABEL for SEALING BOTTLES, F. T. Harris, London.
25,118. HEAT-RETAINING COMPOSITION, F. Aslatt, Southampton.
25,119. PENCIL SHARPENER, A. J. Johnson, Harborne, Staffs.
25,120. GAS ENGINES, J. G. Statter, Birmingham.
25,121. DASHBOARDS for VEHICLES, F. W. Lanchester, Birmingham.
25,122. ROLLER, &c., SKATES, H. F. and C. Smith, London.
25,123. ATTACHMENTS for MEDALS, A. Miesch, Birmingham.
25,124. TABLE TENNIS NET ATTACHMENT, J. Turner, Birmingham.
25,125. ELECTRICALLY SIGNALLING TRAINS, M. Butt, Wolverhampton.
25,126. VALVES, W. H. and R. Thompson, London.
25,127. FILLING BOTTLES, W. Aked, Manchester.
25,128. VALVES, C. Thatcher and J. Renshaw, Manchester.
25,129. OIL FURNACES, H. Igel, G. Rose, and A. B. Lennox, Newcastle-on-Tyne.
25,130. BOTTLE SEALER, W. B. Sweeting Birmingham.
25,131. HOLDING APPLIANCE, W. M. Walters, Liverpool.
25,132. ELECTRIC SWITCHES, H. C. Gover, Margate.
25,133. WIRING MOTION for LOOMS, E. Hollingworth, Dobcross, Yorks.
25,134. COMBING MACHINES, S. Drummond and J. W. England, Keighley.
25,135. TURBINES, M. Clarke and F. J. Warburton, Newcastle-on-Tyne.
25,136. CORK EXTRACTORS, F. W. Blower and W. A. Baxter, Kings' Heath.
25,137. TOBACCO PIPE, C. H. Owen, Cardiff.
25,138. TELEPHONE SWITCHBOARD CORDS, A. Whalley, Helsby, near Warrington.
25,139. GAS ENGINES, H. G. Hills, Manchester.
25,140. "BENWKED," W. Brown, Omagh, Ireland.
25,141. WATER HEATING APPARATUS, M. Sensenschmidt, Liverpool.
25,142. CLOTH TESTING APPARATUS, F. A. Blair, H. Grandage, and G. R. Smith, Bradford.
25,143. TELEPHONE TRANSMITTING APPARATUS, M. Sensenschmidt, Liverpool.
25,144. REACTION TURBINES, F. Hoffbauer, Liverpool.
25,145. CORK SEAL, H. Green, London.
25,146. ELECTRIC SWITCHING APPARATUS, J. D. F. Andrews, East Sheen.
25,147. LIQUID-HEATING APPARATUS, F. Mrowczinski, E. Dittschlag, and H. Grafstedt, Berlin.
25,148. RESPIRATOR, H. Schröder, Berlin.
25,149. BALL LIFTER, A. K. Craufurd, London.
25,150. DATING TICKETS, H. S. Scott, H. F. Tyzack, and A. C. Lumsden, Gateshead-on-Tyne.
25,151. ROLL SEAL LABELS, R. Henderson, Glasgow.
25,152. FURNACES, F. Weber, jun., Zittau, Germany.
25,153. DEVICE for SHADING EYES, E. S. F. Mann, Birmingham.
25,154. PNEUMATIC TIRES, W. M. Savours, Birmingham.
25,155. INDUCTION COILS, H. C. Newton and R. S. Wright, London.
25,156. TROUSERS PRESSER, J. Thomas and D. Edwards, Cardiff.
25,157. ILLUMINANTS, G. Davidson and The Fietz Preliminary Syndicate, Limited.—(*C. Fietz, Italy.*)
25,158. WINDING MACHINES, S. W. Wardwell, London.
25,159. COP TUBE CARRIERS, S. W. Wardwell, London.
25,160. EXPANSION PULLEYS, S. W. Wardwell, London.
25,161. RAIL CLEANERS, J. Thorpe and A. E. Smith, London.
25,162. TREATMENT of FABRICS, F. J. Hill, London.
25,163. WHEELED VEHICLES, C. H. and F. J. Dale, London.
25,164. EXPLOSION ENGINES, &c., T. W. H. Biddle, London.
25,165. STEAM BOILERS, D. S. Forbes, London.
25,166. CLOSING TINS AIRTIGHT, E. M. T. Boddam, London.
25,167. SLEEVE LINK, R. Schmidt, London.
25,168. HANGING CURTAINS of POLES, A. H. Storey, London.
22,169. CUTTING MACHINE for PICTURES, D. A. Lowthime, London
25,170. PROCESS for PRODUCING MOULDS, M. Küller, London.
25,171. ELECTRIC TELEPHONE SYSTEMS, G. A. Cardwell, London.
25,172. SOUND-RECORDING MACHINE, H. Jones and R. L. Gibson, London.
25,173. COAL COMPOSITION, H. H. Lake.—(*Koale Savs Manufacturing Company, United States.*)
25,174. ELECTRIC APPARATUS for ILLUMINATING the THROAT, F. W. Schumacher, London.
25,175. ELECTRIC SIGNALLING, J. B. Struble, London
25,176. PUSHERS for SEWAGE MACHINES, G. J. Stevens, London.
25,177. VALVES, W. O. Foss and M. J. Lincoln, London.
25,178. ROLLER BEARINGS, A. Featherstonhaugh and P. Fitzgerald, London.

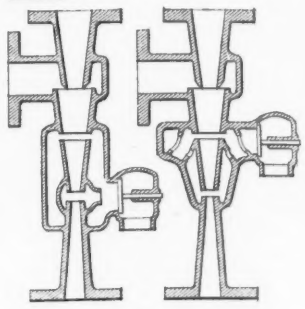
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

679,127. INJECTOR, *C. Prüsmann, Magdeburg, Germany.—Filed February 16th*, 1901.

Claim.—In an injector, the combination with two openings in the mixing nozzle for the escape of steam,

679,127

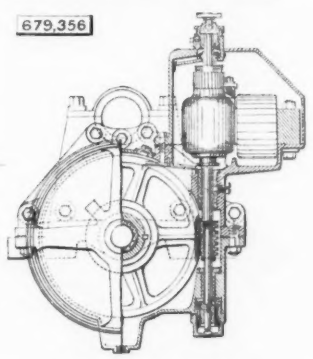


of means for producing a sucking effect through one of the openings upon the liquid by the steam escaping through the other opening, substantially as set forth.

679,358. WORM GEARING, *N. C. Bassett, Lynn, Mass.—Filed October 26th*, 1900.

Claim.—(1) The combination of a worm wheel and a worm shaft adapted to shift endwise under load, with means for giving the worm shaft a bias to counterbalance the normal load driven by the wheel, whereby the friction of end thrust is obviated. (2) The combination of a worm wheel and a vertically-mounted worm shaft weighted to counterbalance the

679,356

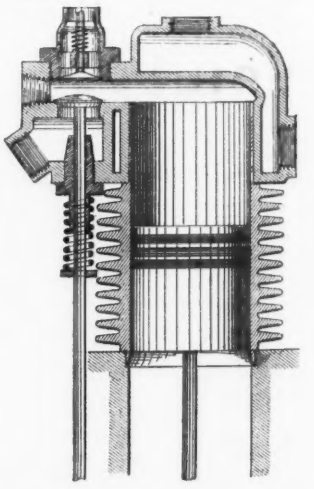


normal load driven by the wheel. (3) The combination of a worm wheel, a worm shaft, means for giving a bias to counterbalance its end thrust, and a dash pot to oppose sudden changes of movement of the shaft. (4) The combination of a worm wheel, a worm shaft, and an electric motor driving the same, the armature of the motor being mounted on the shaft and fixed thereon to hold the shaft against end thrust when symmetrical in its field of force.

679,410. EXPLOSIVE ENGINE, *E. T. Birdsall, New Rochell, N. Y., Filed August 3rd*, 1900.

Claim.—(1) An explosive engine having a cylinder provided with heat-radiating gills; in combination with an explosion chamber provided with a compound water chamber surrounding the explosion chamber and one end only of the cylinder, the junction between said compound water chamber and cylinder being effected by slipping the former over the latter in substantially the manner shown. (2) An explosive

679,410



engine provided with an explosion chamber cast integral with a compound water chamber and adapted to fit snugly over one end of the cylinder of the engine in such manner that the circulating water cools both the cylinder and the explosion chamber, one branch of the compound water chamber being located between the cylinder and the valves of the engine, said compound water chamber and explosion chamber being cast integral and located when in position with its lower end against a ledge or shoulder on the outside of the cylinder, substantially as shown and described.

IRON FOUNDRIES AND FOUNDRY PRACTICE IN THE UNITED STATES.

(By our Special Commissioner.)

(Conclusion)

Y.—MOULDING MACHINES.

THE use of moulding machines is very general, and for a varied character of work, large and small, simple and intricate. The work includes such castings as pulleys and gear wheels, draw-bars for railway wagons, and even bogie frames for tramcars, these latter being 6ft. long and weighing 300 lb. each. The use of moulding machines in certain individual foundries has already been referred to in descriptions of these foundries in this paper, and mention may be specially made of the Westinghouse, Sargent, and Milwaukee and McCormick foundries. The latter, melting 315 tons of iron per day for agricultural machinery, uses machines almost exclusively.

The Latrobe automatic coupling and draw-bar for railway wagons is moulded by machine, cast iron flasks being used, and the moulds being rammed by compressed air rammers. These are large and heavy castings. With hand moulding, a moulder at 12s. 6d. per day, with half the time of a helper at 7s. 4d. per day, could make five moulds in a day, at a cost of 16s. 2d. per day for labour, or 3s. 3d. per mould. With the machines, three men and a boy make sixty-five moulds per day, at £1 7s. 3d. for labour, or 5½d. per mould. The Bettendorf Metal Wheel Company, making metal pulleys and wheels, uses at its two plants about 450 tons of steel a day for rims and spokes, the hubs being of cast iron. The machines used make three-part moulds; one is for the drag, the second for the cheek, and the third for the cope. From this it is evident that the scope of moulding machines is not confined to plain work. Tapered metal flasks are used for these machines and for ordinary moulding.

Several large foundries use moulding machines specially designed and built at their own works for their own particular class of work. These include the Milwaukee, Sargent, and Westinghouse machines. There are at least twenty-five styles of moulding machines in use, as shown by the following list, which is probably not complete, and is not arranged according to order of merit or importance. Those marked with a cross—X—are designed and made by the firms using them, and are not on the market:—

American moulding machines.—(1) Avery; (2) Burns; (3) Delano; (4) Eddy; (5) Farquhar; (6) Farwell; (7) Fulton (X); (8) Groves; (9) Herrman; (10) Little Giant; (11) McCanna; (12) Maywood; (13) Milwaukee (X); (14) Paxson; (15) Pridmore; (16) Racine; (17) Reynolds; (18) Sargent (X); (19) Stearns; (20) Tabor; (21) Turner; (22) Universal; (23) Wachalec; (24) Weiss; (25) Westinghouse (X). Mentton may also be made of the Bryan vacuum moulding machine.

The following is an extract from an article in *Cassier's Magazine*, referring to American practice in this respect.

In many modern foundries moulding machines are an important part of the equipment. These, in American establishments, far outnumber those in British ones. By their aid unskilled hands regularly perform tasks equivalent to those of skilled moulders, and even perform them better and vastly cheaper, so that three advantages are gained—economy in time, economy in wages, and an improved product.

But even in moulding machines there are immense differences, and certainly the last effort has not been made yet in this direction. They are as highly specialised and subject to as great variations as any single engineer's machine tool. Even heavy castings do not now lie outside their sphere of operations, nor do those of considerable depth. If work is of a sufficiently repetitive character, a machine can be selected or devised for it. Hand ramming, ramming by steam, and by compressed air, and by water, all give good results under different conditions, and one cannot be said in general to be better than the other. Theoretical objections to any one of these can be urged, but the sole test is practice, and in practice they are all working successfully. Several firms now make moulding machines of portable types, light machines mounted on plain wheels. Some are of narrow gauge, sand furrows being laid alongside; others of broad gauge, with the sand underneath.

The most complete installation of moulding machines is that in which there is no handling of sand, and in which the moulds are cored and closed by men other than the moulders. This method is adopted in many shops. In the most perfect systems the work is not done adjacent to the machines, and the flasks are not even taken away by hand. In short, the early methods of machine moulding—just an advance on the plain plate moulding—bear about the same relation to the later methods that hand work did to the early machine work.

It may seem invidious to select any for special mention when there are numerous really good tpes. With this disclaimer, note may be made of three—the Pridmore, Adams, and the Tabor. Each is almost a type in itself. The Pridmore, instead of being fixed, goes to the work, a point worth considering. In the Tabor machines—air operated—the sand is rammed by the air pressure over the pattern, and the platen is lifted by air. Even the dry brush is dispensed with, for a flexible air pipe is used to blow the sand from the pattern. The latest development in machine moulding is the multiple, introduced on the Farwell machines of the Adams Company. It saves the labour of pouring a large number of single moulds, and economises floor space. The latter is just as important as the former, because when a floor is being covered with moulds, at the rate of, say, nearly one a minute, it soon becomes full. In the multiple system a pile of moulds is made, each section of which, except the top and bottom, has moulds made on each side. One in-gate passes from top to bottom. The metal then falls to the bottom, filling the lower portion before it runs off into the upper moulds. In practice the hydrostatic pressure does not produce swelled castings in the bottom, because the metal in the runners becomes congealed before the full pressure comes upon them. The limit to the height is set by convenience of pouring and by the pressure on the bottom sand. Multiple moulds of from seven to ten in number are the maximum desirable.

Rapping is one of the greatest obstacles to obtaining uniformity in the dimensions of castings moulded from the same pattern. It is always an uncertain quantity in the hands of different moulders, each man being a law unto himself in this matter. But the loosening of the sand, or else the use of a stripping plate, is essential in order to secure the clean delivery of a pattern. This is, in a large degree, one reason why moulding machines are growing in favour. Reliance can be placed on the uniformity in dimensions of the moulds made with them. In many, stripping plates are used; in some, rapping alone by ordinary work is relied on.

In shops doing a general run of work only, moulding machines would not conduce to economy. For these are expensive, not in first cost, but in the extra expense entailed in the preparation of the patterns, which can be recouped with profit only by a large volume of repetitive work, and because men have to be trained specially to operate the machines. If the work on these slackens, the men are not of much use for ordinary moulding. It is necessary, therefore, to success in this direction that a shop shall have a good run of standard repetitive work, and that it shall get into the system of doing it on machines. Pattern makers and moulders alike have to be trained before the best results are possible. In some shops most of the work can be moulded by machine; in other shops little or none is economically possible.

Z.—STEEL AND MALLEABLE IRON FOUNDRIES.

The making of steel castings is a special branch of the foundry industry, but two steel foundries have been described in this series of papers; namely, the Sargent foundry and the Shickle, Harrison and Howard foundry. Steel is now used for all kinds of work, ranging from locomotive frames and driving wheel centres, engine pistons, &c., to small tools and machinery parts.

A special means of economically making small steel castings by pouring a great number at one time has been devised by Mr. J. W. Harrison, of the National Coupler Company. In the case of wrenches, for instance, as shown in Fig. 59, four moulds will be made in one box, and so gated that six of these boxes set together in two rows side by side are all connected by

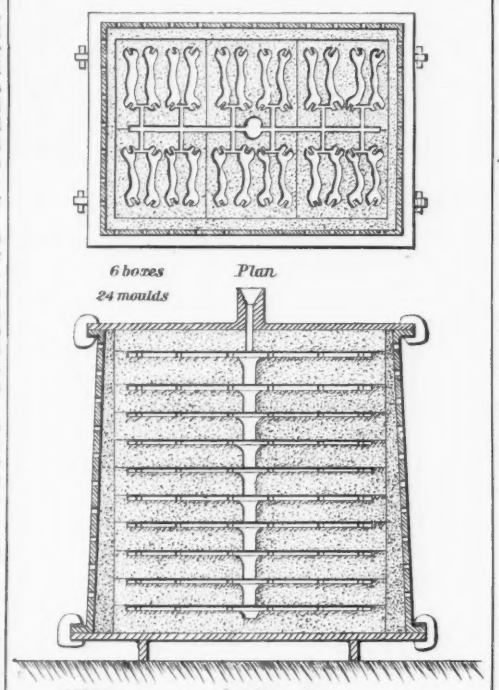


Fig. 59.

runners from a central gate. These boxes are then packed in a rectangular case which just fits them; six boxes—24 moulds—to a layer, and 10 layers in the case, making 240 moulds in all. The gates form one central vertical gate, with horizontal runners in each layer of boxes, and the gates are so shaped that the iron falls directly to the bottom and only spreads into the runners as the gate fills up. In this way from one hundred to one thousand little castings can be made at one pouring, which is of special importance with steel, since this cools more rapidly in the ladle than iron. The loss and waste are also very much less by this multiple system. Mr. Harrison also says that the cost under his system is only half that of casting by the ordinary methods. He has cast 1000 pieces weighing 4 oz. each, at one time, with a loss of only 25 pieces; and he has also cast 500 pieces weighing 4 lb. each.

Within the past few years there has been a great development in the use of malleable cast iron, mainly for small work, but also for a number of large pieces. The material is extensively used for the metal fittings of railway wagons, draw-bars, bolsters for wagon bogies, signal fittings, smoke-box steam pipes, excentric straps, and other locomotive parts, axle-boxes, and other railway work; also pipe fittings, sprocket chains, and parts of agricultural and electrical machinery. Its important economy lies in its greater strength for less weight than ordinary grey iron castings. Its tensile strength is usually from 40,000 lb. to 48,000 lb.

Cupolas, reverberatory furnaces, and the Siemens-Martin open-hearth furnaces are used in producing the metal for malleable castings, the first of these being used generally for small work only, as the character of the metal is less under control. Basic furnaces have also been tried. Attempts have been made to cast a suitable metal direct, without annealing, but these have been mainly unsuccessful. A special grade of pig iron is made by many blast furnaces for malleable work, and the malleable iron made in a coke furnace is generally slightly higher in sulphur than that made in a charcoal furnace.

When malleable castings first began to be generally used there was a great rush to establish works for their manufacture, but as the processes are of a special character and require great skill, there was a lack of competent men to manage the works. The specifications for malleable castings were also very vague. In many cases the so-called malleable castings were little better than common grey iron castings. The character of the material, especially in regard to uniformity and reliability, has been greatly improved by the introduction of scientific methods in regulating the grade of iron, the heat of the furnace, and the operation of the annealing ovens. A steady uniform heat is required to produce good castings. Where the ovens are heated by coal or coke great care is required to maintain a uniform temperature, but this difficulty is greatly reduced where oil or gas is used for fuel.

If the packing is charged with sal-ammoniac the castings will be softer, the carbon being less, and consequently the elongation and the reduction of area in the test bar being greater. In iron for malleable castings it is generally aimed to keep the carbon and silicon low to produce a soft iron; while manganese is kept fairly high to check the shrinkage, and the manganese is little, if at all, reduced in the oven. Sulphur and phosphorus are also kept low on account of their hardening tendency. In round test bars, 12in. long, tests made with the "hard iron," before annealing, and the "soft iron," after annealing, have given the following comparative results as to shrinkage in the length of 12in.

Hard iron. Inch.	Soft iron. Inch.
0·225	0·090
0·225	0·100
0·235	0·125
0·237	0·087

NOTES.

In regard to the various special facilities instituted in the foundries described in the earlier parts of this series of papers, the following recapitulation may be given for convenience of reference:—

Sand conveyors, with feed to moulding benches or floor. — McCormick, Milwaukee and Westinghouse foundries.

Water supply piped around the floor.—Milwaukee and Westinghouse foundries.

Natural gas supply.—Westinghouse foundry.

Electric call system.—Milwaukee foundry.

Laboratory.—Shickle, Harrison and Howard foundry, and Milwaukee foundry.

Heating, ventilation, lighting, and fire protection.—General Electric, McCormick, Milwaukee, Sargent, and Walker and Pratt foundries.

Wash basins and toilet rooms.—General Electric, Milwaukee, and Walker and Pratt foundries.

Cleaning sand.—Walker and Pratt, and Westinghouse foundries.

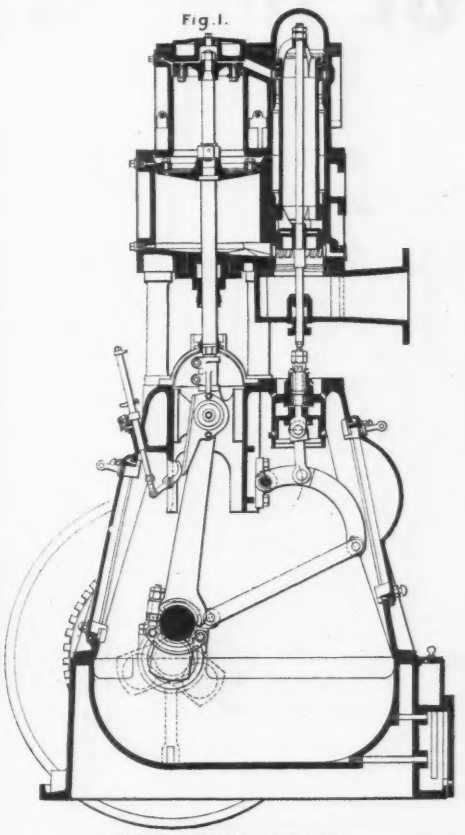
Telephone service.—Walker and Pratt foundry, and Milwaukee foundry.

STEAM ENGINES AT THE GLASGOW EXHIBITION.

No. XII.

A VERY considerable proportion of the power used in the Machinery Hall was supplied by the steam engines of Davey, Paxman and Co., of Colchester. The dynamo of the General Electric Company, which we have already noticed, was driven direct by one of their "Peache" engines. This is a triplex vertical compound engine, with three cranks at 120 deg., and each pair of small and large cylinders placed tandem. The lower end of high-pressure cylinder and upper end of low-pressure cylinder are freely open to each other. The section of the engine through one pair of cylinders is seen in Fig. 1. From this section it is seen that the two cylinders are served by a piston valve of three rings upon one stem. Steam enters by the external mid-length part of the valve, and is admitted to the top side of the small piston by the under side of the top

Fig. 1.

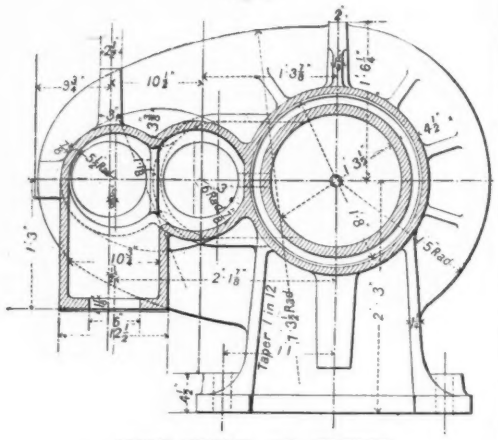


PEACHE HIGH-SPEED ENGINE

ring. It exhausts by the top side of this ring and descends through the hollow of the valve, to be admitted by the top edge of the lowest ring to the under end of the low-pressure cylinder. The middle valve ring serves as a bar between the boiler steam and the low-pressure valve port. The exhaust is by the bottom edge of the lowest valve ring. The valve rod gland is exposed to exhaust steam only. The valve chest liner is of cast iron. On the up stroke the volume between the top and bottom pistons diminishes, and the pressure rises so as to form a cushion. Steam is admitted to this space through a slot in the wall of the high-pressure cylinder, just below the piston at the top of its stroke. On the down stroke the reverse of this action occurs. Thus the result is to store some of the work of the steam on the up stroke and give it out on the down stroke.

At the commencement of the down stroke the full

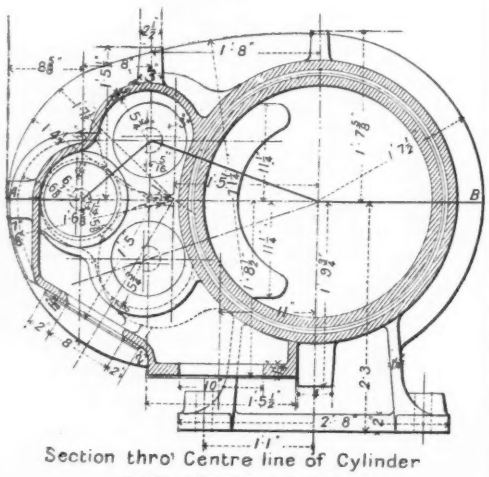
Fig 2.



CROSS SECTION, H.P. CYLINDER

effective area exposed to acting steam pressure is that of the large piston. At the beginning of the up stroke the effective piston area is the difference between the large and small pistons. The cylinders are 11in. and 17½in. in diameter by 11in. stroke. The valve diameter is 6½in. There are no jackets on either cylinder. At the Exhibition 140 lb. per square inch pressure was used, and this at 350 revolutions per minute yields 360 indicated horse-power. The steam is supplied through a simple form of vertical cylindrical separator. The piston packing rings are held down by a spring junk ring, and if water gets between the piston and end cover this junk ring yields and acts as a relief valve. The high-pressure piston is a steel casting, and the low-pressure piston is forged in steel. The drain cocks of the three low-pressure cylinders are linked together, as also are the three drain cocks on the high-pressure cylinders. The piston-rod has an asbestos gland packing. There is a four-cock turret lubricator, the four tubes leading to the three high-pressure cylinders and to the throttle valve. Each pair of cylinders stands on four wrought iron studs upon the enclosed chamber frame, in which the shaft and connecting-rod ends get splash lubrication. The crosshead guide is bored out to 9¾in. The similar guide for the valve stem is also bored out. In this latter the crosshead is of piston form, and cushions

Fig 3.



CROSS SECTION, L.P. CYLINDER

the up-throw of the somewhat heavy valve, thus keeping the pressure always on one side in each joint. As seen in Fig. 1, the valve motion is obtained through a quadrant lever, pivoted at the side of the crosshead guide. The outer end of this lever is moved direct from the big end of the connecting-rod through an inclined link, whose obliquity determines the lead (or equivalent angular advance) of the valve, and whose length is also influential in modifying the steam distribution. All the valve gear is of mild steel, with case-hardened steel pins and phosphor bronze bushes.

The design of the cap of the connecting-rod big end should be noted; it is clearly seen in Fig. 1. The connecting-rod is a wrought iron forging. The inclined plane on the side of the crosshead and the wiping lever resting against it are for obtaining motion for the indicators. The correctness of the motion so obtained depends on the form of the wiping lever. The crosshead is a steel casting with a split neck bolted tight on the screwed end of the piston-rod. The cut-off is a constant one, and the whole governor regulation is by throttle. A two-ball two-spring horizontal spindle centrifugal governor is used, running at 450 revolutions per minute. It is belt-driven and is enclosed, outside the casing being placed a large spiral spring speed-adjuster. A peculiarity of the engine is that the crank shaft is put out of line with the cylinder centre lines by 5in. There is a notion that this helps the engine over the dead points; but its real effects are to modify the steam valve distribution, and to make the up and down piston strokes one slightly faster than the other. As the total piston pressure is upwards at the beginning of the up stroke, this 5in. side shift seems to ensure that the crosshead pressure passes from one to the opposite face of the guide at least twice per revolution. There are four main shaft bearings in this engine. Three of these have 10in. length and the fourth 15in., while all four are 5½in. in diameter. The shaft is also 5½in. throughout. The crank pin is 5½in. by 7½in. long, and the crosshead pin 3⅝in. by 4½in.

In another part of the Machinery Hall Davey, Paxman had a large horizontal cross-compound engine designed for tramway service, which we illustrate by a supplement to-day. It has mounted on its shaft, between main bearings, a dynamo built by the Electric Construction Company. This dynamo we have already fully described. The normal speed is 150 revolutions per minute, and the steam pressure is 160 lb. per square inch. The two cylinders are of 15½in. and 27in. diameter by 30in. stroke. The supplement shows a good perspective view. Figs. 2 and 3 are cross sections through the high-pressure cylinder and valves and through the low-pressure cylinder and valves respectively. Figs. 4, 5, 6, and 7 are longitudinal sections through high-pressure main and expansion valves, and low-pressure main and expansion valves. The engine is commonly used with an independent surface-condensing plant; but at the Exhibition no facilities had been supplied to any of the engine-makers for condensation. The cylinders are not jacketted, the engine being designed to use steam superheated to 650 deg. Fah. In passing between the cylinders the steam is reheated by being sent through a chamber in which lies a nest of 1⅛in. steel tubes. Fresh boiler steam passes through these tubes. The exhaust from the low-pressure cylinder is used to heat the boiler feed by a nest of 2in. steel tubes expanded into a steel tube plate, and giving 200 square feet of heating surface. The crosshead guides are bored to 22in. diameter. The crosshead is a steel casting with cast iron slippers 12in. wide by 15½in. long. The fly-wheel is 10½ft. in diameter, and weighs 10 tons. It is

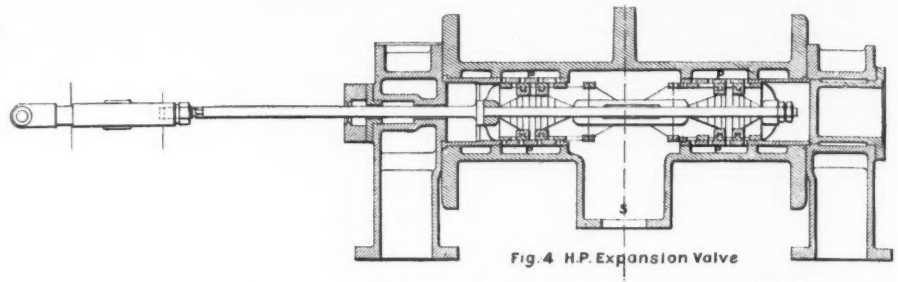


Fig. 4 H.P. Expansion Valve

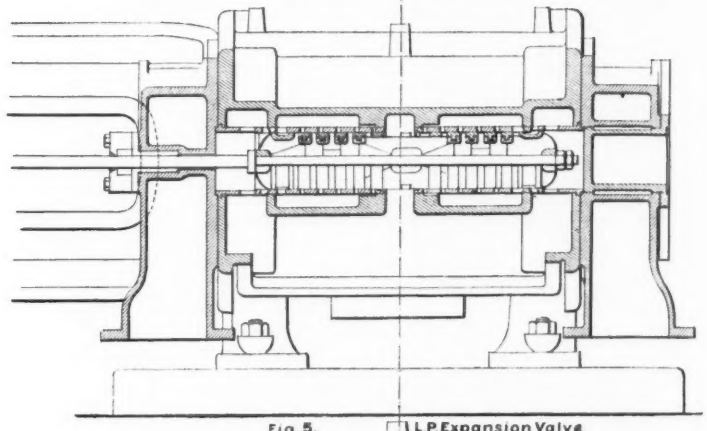


Fig. 5. L.P. Expansion Valve

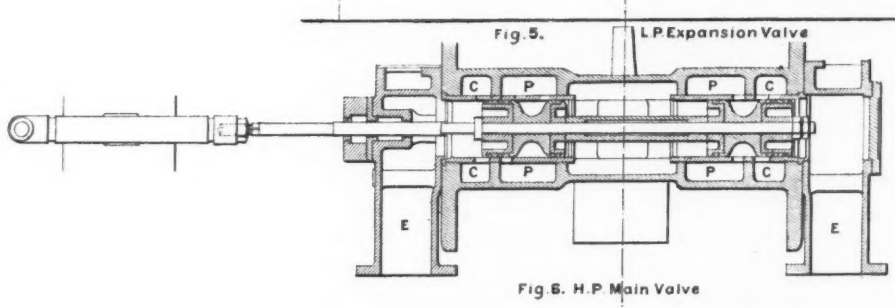
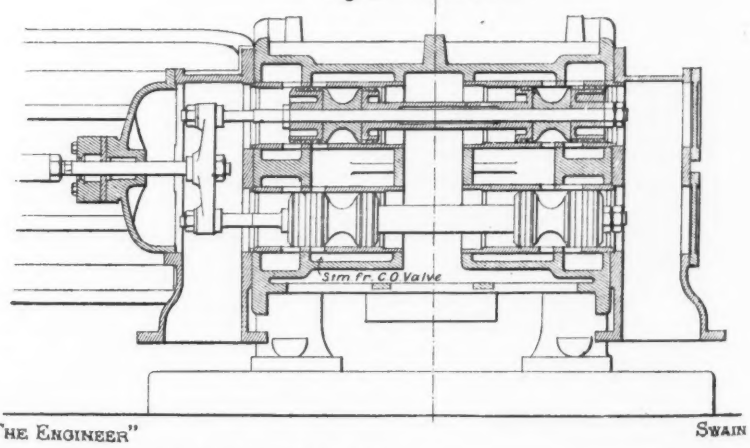


Fig. 6. H.P. Main Valve

Fig. 7. L.P. Main Valve



"THE ENGINEER" SWAIN

STEAM DISTRIBUTION VALVES

cast in halves, these being held together by four bolts at the boss and by four forged steel hoops of 2in. by 1in. rectangular sections at the rim. A 4ft. diameter flange coupling connects the fly-wheel to the dynamo. The governor is a three-ball vertical spindle one. The outward motion of the balls lifts the case, the weight of which acts along with a strong central spring. This governor is driven by bevel gear from a small return crank shaft lying outside the main bearing on the low-pressure side. A rocking shaft crosses from the low to the high-pressure side, and the governor, through this shaft, acts on the cut-off in both high and low-pressure cylinders, and on both in the same manner This arrangement of making the governor control the cut-off in the low as well as in the high-pressure cylinder of a compound engine is contrary to theoretical conclusions, and contrary to most modern practice; but it is adhered to by not a few engine builders of high reputation. It would, therefore, be very interesting to have a defence of it from some such makers.

It may be noted that re-heating between the cylinders invalidates to a certain limited extent the theoretical conclusions referred to, which do not contemplate such re-heating.

On both high and low-pressure cylinders the distribution is regulated by a main valve of the piston type, driven direct by a fixed excentric, and by cut-off valves, which are also of piston type and are driven each through a link motion by two excentrics, one of which has 1¾in. and the other 1½in. throw. Below normal speed the valve gets its whole motion from the 1¾in. throw excentric. These valve gears are identical on the two sides.

Fig. 2 gives a section of the small cylinder and its two valve casings. Cast iron port liners are inserted in these cases. These and the two valves are seen in Figs. 6 and 4. Both valves are of 7½in. diameter. The steam enters at S in Fig. 4 to the centre of the grid or four-ported expansion valve, each port being ½in. wide, and passes through this to the ports marked P P P P in Fig. 6. The solid double piston main valve, Fig. 6, passes the steam by its external recess to the ports C C C C leading to the cylinder, each port being here 2in. wide and the exhaust is from these ports C by the end edges of the piston to the ports E E. The main valve-rod gland is thus exposed to exhaust steam only, while the expansion rod gland is exposed to boiler steam. This latter exposure could be avoided by making the extreme ends of the valve solid instead of open, as shown in the drawing. The passage through the valves on the low-pressure side is arranged in precisely the same manner, as seen in Figs. 7 and 5. Here all the three valves are again 7½in. diameter. The expansion slide is six-ported, each port being ½in. wide. The main valve is duplicated, as seen in Figs. 7 and 3. The ports are 2in. wide, giving a total port area of $2 \times 2 \times \pi 7\frac{1}{2} = 94\frac{1}{4}$ square inches. The low-pressure piston area is 572 square inches, or rather more than six times the port area. The mean piston speed being 750ft. per minute, the nominal steam velocity in the ports is about 4500ft. per minute. All these valves are of cast iron.

Davey, Paxman and Co. were among the two or three exhibitors of boilers under steam. Theirs was a two-flue return-tube "Paxman Patent Economic." It contains one hundred 3in. tubes, 14½ft. long, of which sixteen are stay tubes, reinforced by six solid 3in. stay rods. The flues are 3ft. diameter, and the shell 8ft. 9½in. The grates are 6½ft. long, giving 39 square feet area.

In connection with the boiler they exhibited a superheater, consisting of a cast steel header box at the back, into which are expanded the two ends of each of a nest of U-bent solid-drawn steel tubes, arranged in seven sections, sixteen tubes in each, the seven being built in a vertical tier. This is heated by an independent fire-grate, the fire-door being fitted with a thick asbestos block on its inside surface. Bye-passes are arranged, both for the boiler flue gases and for the steam, so that the superheater may be used in different fashions. The workmanship of these boiler and engine exhibits is of the high class for which the firm is well known.

THE TRANS-AUSTRALIAN RAILWAY SCHEME.

By STAFFORD RANSOME, M. Inst. C.E.

Now that the Federal Parliament has pledged itself to complete the linking up of the capitals of the various Australian States by means of one line of railway, reaching from Brisbane *viâ* Sydney on the east coast to Perth—or, to be more accurate, Fremantle—on the west, the subject becomes one of world-wide interest. The effect of this railway will be to so facilitate intercourse between the various States as to revolutionise the passenger and goods traffic on that continent.

It is true that the only capital isolated from the others at the present time is Perth; but then that isolation has had a retarding influence on the development of Western Australia, and the other States have lost much owing to this want of facilities for intercommunication.

At present, of course, Western Australia can only visit her nearest neighbour by sea, so that to all intents and purposes she is a huge island, and although in actual distance Perth and Adelaide are only about 1300 miles apart, the fact remains that it takes about as long to travel from the one to the other as it does from England to the United States.

It would be premature to attempt a full description of the new work proposed; for the "battle of the routes" is raging still, and can only be decided when the detailed surveys now being carried out by the South Australian and Western Australian Governments have been completed. The country to be spanned by the new line lies between Kalgoorlie in Western Australia, and Port Augusta in South Australia, and the distance between these two points is estimated for railway purposes at 1025 miles, if the projected route, *viâ* Eucla, which I have shown on the map herewith, is followed, or 1100 miles, if another and rather more northerly route is preferred. The latter, which is known as the Tarcoola route, would strike the frontier between the two States at a point about sixty miles north of Eucla. Western Australians prefer the Eucla route on the ground that it is the shorter, and would bring the port of Eucla into their railway system; and South Australians favour the Tarcoola route, because it would suit them better for their railway to pass to the north rather than to the south of the Gawler range of mountains in their own State. This, however, is merely a side question, and does not affect the main issue.

The great variety of gauges in the various States has made the question of selection of a gauge for the projected line a rather vexed one. It is now proposed that the gauge of the new section shall be 4ft. 8½in., although this does not coincide with the gauges of the lines at either end of it. New South Wales is the only Australian State where the standard gauge is 4ft. 8½in. Passengers from Fremantle to Brisbane will travel in five different trains on account of continual change of gauge. From Fremantle to Kalgoorlie the gauge is 3ft. 6in.; from Kalgoorlie to Port Augusta it will be 4ft. 8½in.; from Port Augusta to Albany it is 5ft. 3in.; from Albany to the Queensland frontier, 4ft. 8½in.; and from the frontier to Brisbane, 3ft. 6in. Although one of these changes could have been avoided by building the new line to either a 3ft. 6in. or a 5ft. 3in. gauge, the present proposal for a 4ft. 8½in. gauge is a sound one. It is now generally admitted that any gauge beyond 4ft. 8½in. entails unnecessary expenditure without compensating advantages, and it is known that full results, when it is a question of continual heavy traffic, cannot be obtained from a 3ft. 6in. line.

The rapid increase in the traffic in Western Australia, even under past conditions, has been making it apparent that this gauge was too narrow for the growing requirements, and there is no doubt that at an early date, after the completion of the trans-continental line, the gauge between Fremantle and Kalgoorlie will be widened to correspond with it.

The complete system, allowing 1100 miles for the new sections, will measure from Fremantle to Brisbane 3529 miles, made up as follows:—

Fremantle to Kalgoorlie	387	miles.
Kalgoorlie to Port Augusta	1100	,,
Port Augusta to Adelaide	259	,,
Adelaide to Melbourne	483	,,
Melbourne to Sydney	576	,,
Sydney to Brisbane	724	,,
Total	3529	miles.

It is reckoned that a mean speed of 40 miles an hour can be maintained, and that this, allowing for stoppages, will make the complete journey feasible in 96 hours. Thus:—

Fremantle to Kalgoorlie	10	hours.
Kalgoorlie to Port Augusta	29	,,
Port Augusta to Adelaide	7	,,
Adelaide to Melbourne	14	,,
Melbourne to Sydney	16	,,
Sydney to Brisbane	20	,,
Total	96	hours.

The greatest share in the advantages obtained by the new railway will fall to Western Australia. In fact, it was largely because the promise of a trans-continental railway was dangled before the Western Australians as a bait that they, at the last moment, decided to join the Federation. The fact that Sir John Forrest, ex-Premier of Western Australia, holds the portfolio of Minister of Communications in the Federal Government is enough guarantee that the project will not be neglected, and that when the time comes the work will be pushed forward with energy.

It is considered that from the date of starting operations the new section could be completed in four years, especially if the Eucla route were to be adopted. This route, it is maintained, would offer facilities for construction eastward and westward simultaneously from a central point, in addition to the work carried on eastwards from Kalgoorlie, and westwards from Port Augusta. The advocates of this route also very rightly claim that Eucla, being a suitable port for large ships, the cost of transport of material for the central portion of the section would be much lower than by the more northerly route.

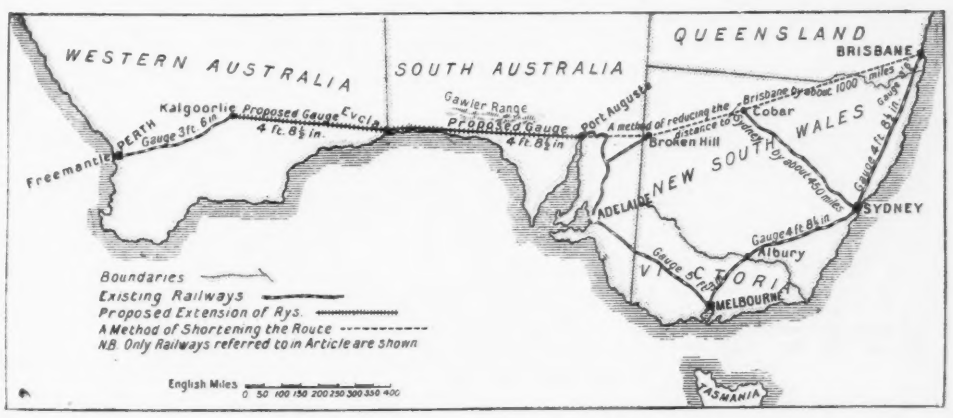
Estimates as to the cost of construction are necessarily vague at the present stage; but the general impression is that it would not exceed five millions sterling, and that it might be covered by four millions. It is practically certain that there are no very serious geological difficulties to be overcome, though a lack of water over a portion of the Western Australian section appears probable. As a rule this section of the line will run through a desert of the same nature as that which the Kalgoorlie line traverses. Optimists declare that this country will prove as auriferous as that which has already been tapped, and if so the railway should prove a gigantic success from this source alone. In parts there is plenty of timber suitable for sleepers and buildings, and there is an abundant supply of stone for ballast and building purposes.

One of the great features possessed by the completed line will be that it will bring into touch by railway every State in Australia with the Western Australian goldfields. From the most remote of these, Queensland, the man who wants to try his luck at the diggings will be able to reach them in less than four days. Hitherto he has had to make a lengthy and expensive sea voyage with a railway journey at the end of it, and he has accounted himself lucky when he has reached his destination in less than a fortnight.

Then, again, the cost of living in Western Australia will be greatly reduced by facilitating the importation and cheapening the cost of the many food stuffs produced by the other States, and the comforts of life will be greatly enhanced at the goldfields. By this new enterprise the vast deposits of silver, tin, lead, copper, and iron in South Australia will be placed in railway touch with the Western coast. A reference to the map will show, too, that the Broken Hill district in New South Wales has a branch linking it into the transcontinental system.

We must not forget that, without the advantage of this railway, Western Australia has, as nearly as possible, quadrupled its population during the last ten years. This has been mainly due to the exploitation of gold, first at Coolgardie, and now, more particularly, near Kalgoorlie. Now that an enormous further tract of country is about to be tapped by railway, and communication facilitated from the east, it is hard to prophesy what the growth of the population will be; we must bear in mind the fact that hitherto mining in Western Australia has, generally speaking, been restricted to very shallow working, owing to the scarcity of water making it too expensive a matter to go far below the surface. This will all be revolutionised before the trans-continental railway is finished, as an ample supply of water will have been established up to Kalgoorlie by what is known as the Coolgardie Water Scheme. This will enable the resumption of work on mines that, under the old conditions, were said to be played out from a commercial standpoint.

Nor must we overlook the fact that the trans-continental railway must act as an active agent in populating Australia from outside sources. Many passengers from Europe, either pressed for time, tired of the voyage, or not relishing the prospect of rounding the dreaded "Leeuwin," will forsake their ships at Fremantle, and traverse the whole continent. The first half of this journey to the outside world has been unknown until now, and the object lesson which it will present in the mining wealth of the country cannot fail to bring both the man with money and the man who wants it. All this means success to the railway and prosperity to Australia, but it also points to the fact that side by side with pastoral and agricultural Australia there will spring up a mining and



PROPOSED TRANS-AUSTRALIAN RAILWAY

Apart, however, from the commercial prospects of this railway, much stress is laid on its strategical value. Doubtless it will be of the greatest importance for defensive purposes, as it is essential, in so thinly populated a continent, with so large an area, that every facility should exist for concentrating troops at short notice in a given spot. For this purpose, too, the advisability of the 4ft. 8½in. gauge, rather than a narrower one, becomes apparent. The inadequacy of the 3ft. 6in. gauge in war time was practically demonstrated in Japan during her war with China. It was found, among other drawbacks, that horse-boxes could not be placed crosswise in their cars, and consequently, in a given number of cars, less than half the number of horses could be conveyed than would have been the case with a wider gauge.

When finished in the form at present projected it is not likely that this line will continue to be the only route across the Continent. At all events, it may be presumed that the distance from Port Augusta to Sydney will be shortened. A glance at the dotted lines on the map will show that, with the exception of a gap of less than 300 miles between Broken Hill and Cobar, in New South Wales, there already exists a more direct route to Sydney and Brisbane than that which will pass *viâ* Adelaide and Melbourne. If this distance were spanned, and a more direct railway built between Port Augusta and Broken Hill, the distance between Fremantle and Sydney or Brisbane would be reduced by about 450 miles. And again, looking still further into the future, if a direct railway were built, as also indicated by dotted lines, between Cobar and Brisbane, the distance between Freemantle and Brisbane would be reduced by rather more than 1000 miles. This would mean that, at the present estimate of speed for the forthcoming line, the journey from Sydney or Brisbane to Freemantle, on the problematical sections of railway that I have foreshadowed, could be done in less than three days.

In conclusion, I would say that in drawing up the sketch map I have omitted every railway or town that was not essential for the purpose of this article; the directions of the existing railways are approximate only, the essential points being accurately placed. In showing in the projected railway, and possible further extensions, I have followed the system of the Emperor of Russia when he designed the railway from St. Petersburg to Moscow. I have taken a ruler and made a straight line between the two points.

THE FACTORY ACT, 1901.

THIS Act, which comes into force on January 1st, 1902, makes certain very important changes in the law relating to factories and workshops. All the former Factory Acts, which by reason of their disjointed character have been very difficult of interpretation, have been repealed, and are now re-enacted in one codifying statute which comprises 163 sections. Seeing that certain of these sections contain new matter which is not apparent to any one who has not studied the older Acts, a short survey of the statute may serve to indicate how far the Factory Acts 1878-1895 have been subjected to modification. In the early part of the last session of Parliament a Factory Act Amendment Bill and a Factory Act Consolidation Bill were introduced in the House of Commons. These were eventually merged into one Bill, which, with one or two modifications made in the House of Lords, has now been placed upon the statute book.

The Act is divided into ten parts, with which, so far as they contain new matter, it will be convenient to deal seriatim.

Part I.: *Health and safety.*—With regard to health, certain important changes have been made in the law in connection with temperature and ventilation in factories and workshops, and the drainage of floors. It is now provided by Sec. 6 (1) that adequate means must be adopted to maintain a reasonable temperature, but that such measures must not interfere with the purity of the air in any room where persons are employed. By Sec. 7 the Secretary of State is given power to prescribe a standard of ventilation in each class of factories and workshops, while Sec. 8 provides that in every factory where a wet process is carried on suitable precautions must be taken for draining off the wet. With regard to safety, steam boilers are in future to come within the ken of the factory inspector, *i.e.*, they are in a sense to be regarded as "dangerous machines." By Sec. 11 steam boilers used in factories or workshops must have proper safety valves, &c., and be examined by a competent person every fourteen months. With regard to machinery in motion, it was formerly the law that no child should be allowed to clean any machinery while in motion by steam, &c. This prohibition is now extended to cleaning *under* any machinery in motion other than overhead mill gearing.

As to dangerous machinery, it was formerly within the power of a court of summary jurisdiction to make an order prohibiting the use of a machine proved to be dangerous. This provision is now extended (by Sec. 17 of the new Act) to "any part of the ways, works, machinery, or plant" used in a factory or workshop. The provisions of the Act with regard to accidents are a simple re-enactment of the older statutes.

Part II.: *Hours of employment.*—With one exception, this branch of the factory law has undergone no amendment. We refer to the alteration of employment for women, young persons, and children on Saturdays in textile factories. Under the old Act, if not less than one hour was allowed for meals on that day, employment for a manufacturing process ended at one o'clock on that day. In other cases it ended at half-past one. Now, by Sec. 24 (3) of the new Act, these times are altered to noon and half-past twelve o'clock respectively. This change was not effected without considerable discussion in the Grand Committee on Trade. By Sec. 41 certain important industries are excluded from the operation of that part of the Act which relates to hours of employment and holidays, *e.g.*, the fish and fruit-preserving industries and creameries. Overtime for women in non-textile factories has been cut down from three days a week to two days in a week (Sec. 49); while in the case of perishable articles, the permitted amount of overtime is reduced from five to three days in any one week, and from sixty to fifty days in any year.

An important change has been made in the age at which children may be employed in a factory or a workshop. The age limit was formerly eleven; it is now provided that no child under twelve shall be employed in such places, if not lawfully so employed at the commencement of the Act (Sec. 62). The "certificate of fitness" which a certifying surgeon is empowered to give may, in future, be qualified by conditions as to the nature of the work to which a child may be put (Sec. 64).

Part IV.: *Dangerous and unhealthy industries.*—Perhaps the most important change in this branch of the law is made by those sections of the new Act which empower the Secretary of State to make regulations for dangerous trades. Hitherto the power of the Secretary of State has been limited by Sec. 8 of the Act of 1891 to making regulations in the case of any machinery, or process, or particular description of manual labour which he should consider dangerous. The workman had no power to interfere in the making of regulations. Now, however, by Sec. 79 of the new Act, where the Secretary of State is satisfied that any manufacture, machinery, plant, process, or description of manual labour used in factories or workshops is dangerous or injurious to health, or dangerous to life or limb—either generally, or in the case of women, children, or any other class of persons—he may certify that manufacture, &c., to be dangerous, and thereupon may make such regulations as appear to him to be practicable. Notice of such regulations must be given to persons interested, and an inquiry must, if necessary, be held, at which workmen and occupiers may be represented. Regulations so made may prohibit the employment of any class of persons in any particular industry, and prohibit or limit the use of any particular process. They are not to come into full force until they have been laid on the table of both Houses of Parliament for forty days. Any occupier, owner, or manager committing a breach of such regulations is liable to a fine not exceeding £10.

Part V.: *Special modifications and extensions.*—The old Factory Acts contained many exceptions from and modifications of the generality of the law. The new Act contains a clause which absolutely prohibits the use of any place underground as a bakehouse, unless it was so used on January 1st, 1896, and even those bakehouses may only be used subject to very important restrictions. (See Sec. 101.)

With regard to laundries, the law is unaltered by the new Act. As will be remembered, a clause was introduced in the Amendment Bill first presented to the House, whereby all such institutions in the United Kingdom were brought within the pale of the Factory Acts. Owing to the opposition of the Irish members, who alleged that this would entail an intrusion upon the privacy of Irish convents, this clause was withdrawn, and Sec. 22 of the Factory Act of 1895 was re-enacted as Sec. 103 of the new Act.

In the case of docks, we come to a most extraordinary change made by the new Act. All the more important provisions of the Act are to have effect, as if "every dock, wharf, quay, and warehouse, and all machinery or plant used in the process of loading or unloading or coaling any ship in any dock, harbour, or canal, were included in the word 'factory,' and as if the purpose for which the machinery is used were a manufacturing process." The definition formerly ran—"every dock, wharf, quay, and warehouse, and so far as relates to the process of loading or unloading therefrom or thereto, all machinery and plant used in that process" (see Factory Act, 1895, Sec. 23). This extension is of particular importance in view of the fact that the Workmen's Compensation Act extends to factories as defined in those Acts. Hence the application of the famous Act of 1897 has been considerably extended—*i.e.*, to ships unloading or coaling in any dock, harbour, or canal. It will be interesting to see how soon this extraordinary piece of backhanded legislation comes before the Courts for consideration.

Another important extension of the factory law is contained in Sec. 106, where the provisions above referred to as applied to docks are applied to railway sidings.

Part VI.: *Home work.*—By Sec. 110, which comes in this part of the Act, the district council is empowered to make an order forbidding the giving out of any work such as the cleaning, &c., of wearing apparel, to the inmate of any house where there is infectious disease.

Part VII.: *Particulars of work and wages.*—Hitherto the provisions of the Factory Acts relating to particulars of work and wages have been applied solely to the textile industries. These provisions are now reproduced in Sec. 116 of the new Act, with this important addition, that if the Secretary of State is satisfied by the report of an inspector that the provisions of the section should be made applicable to non-textile factories, he may make an order to that effect subject to such modifications as seem to him to be expedient—see Sub-sec. (5).

Part VIII.: *Administration.*—With regard to certifying surgeons, an important change is made by the non-re-enactment of Sec. 74 (4) of the Factory Act, 1878, which reads as follows:—"The occupier may deduct the fee, or any part thereof, not exceeding in any case threepence, from the wages of the person for whom the certificate was granted."

The general register to be kept at a factory must in future give particulars relating to:—(1) The children and young persons employed in the factory or workshop; (2) the limewashing of the factory or workshop; (3) every accident occurring in the factory or workshop, of which notice is required to be sent to an inspector; (4) every special exception of which the occupier of the factory or workshop avails himself; (5) such other matters as may be prescribed (Sec. 129). Every district council *must* keep a register of all workshops situate within their district. This has been customary in the past, but it is now made compulsory.

Part IX.: *Legal proceedings.*—The one important change in the law which is to be found in this part of the Act is contained in Sec. 144 (5), which provides that "a person engaged in, or being an officer of any association of persons engaged in, the same trade or occupation as a person charged with any offence under this Act, shall not act as a justice of the peace in hearing and determining the charge."

Part X.: *Supplementary.*—This part of the Act relates to applications and definitions. By Sec. 150 (1) the Act is applied to factories and workshops belonging to the Crown; but in case of any public emergency the Secretary of State may, by order, to the extent and during the period named by him, exempt from this Act any factory or workshop belonging to the Crown, or any factory or workshop in respect of work which is being done on behalf of the Crown under a contract specified in the order. The expressions "tenement factory" and "tenement workshop," so often used in the Factory Acts, are now defined for the first time by Sec. 149 (1).

There are appended to the Act seven lengthy schedules relating to the following matters:—Schedule I., provisions as to arbitrations; II., list of factories and workshops in which overtime is allowed; III., regulations as to grinding in tenement factories; IV., table of humidity of air in cotton cloth factories; V., fees for certifying surgeons; VI., list of factories and workshops to which the Act applies. Among these are included for the first time "electrical stations," that is to say, any premises, or that part of any premises, in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking. VII. Enactments repealed from the commencement of this Act.

Such is a brief outline of the changes made by the new Act. Even if such changes had not been made, the Factory Act, 1901, would still have been regarded as an advance upon the old law, inasmuch as it reduces the chaotic confusion of the Acts of 1878-1895 to something which is a near approach to order.

LITERATURE.

Taschenbuch der Deutschen und der fremden Kriegsflotten. Third year, 1902. By BRUNO WEYER, Kapitänleutnant Munich: J. F. Lehmann.

THIS German pocket-book exhibits a marked improvement this year. Its photographs of the German fleet, which serve as a species of frontispiece, are still not all up to date: but in these days of incessant changes this may well be forgiven, for these illustrations are, after all, but a secondary feature, and as the book is issued at about half-a-crown, it is perhaps much to expect the photographs of ships to be renewed yearly. That is practically the only alternative now-a-days. At the same time, for the later vessels we note the extension of a feature introduced last year, namely, photographs of the models, which is decidedly interesting, the more so as the reproductions, though small, are very clear. Extensive data of the German fleet are given; though these are chiefly connected with *personnel*, they touch on other things also. The tables of warships, German and foreign, call for no remark, being substantially the same as one finds in other naval pocket-books. The German spelling gives something that would delight Mark Twain were he a naval expert. For instance, our old friend the Japanese Chin Yen is barely recognisable as the Tschin Jen, and the Russian Peter Veliky comes queer to our eyes as the Pjotr Weliki, though this may be more legitimate than spelling Giliak "Giljka." We mention these cases, not from a hankering after Mark Twain's German done nautically, but because the English-speaking student of the Taschenbuch may well get fogged over obscure Russian or Japanese ships without some such warning. A good feature of these tables is that the length of the gun in calibres is generally given. The fact that a gun is 12in. or 6in. has next to no meaning in these days. We may point out, however, that the Canopus class carry guns of 40, not 45 calibres, though this mistake is common over here as well as in Germany. This, and an unfamiliarity with the new armament of the Renown, are the only errors we can note in the British fleet—a better record than some naval annuals published in this country can make.

The naval estimates of the various nations are given with diagrams *à la Daily Mail*, and following this is a short article upon "Can Great Britain Keep the Command of the Sea?"—argued, of course, from the German standpoint. By this we are at present equal practically, on paper, to Germany, France, and Russia, but selecting a fifteen years' standard, have but thirty-two ships of 444,600 tons against forty-eight of 500,700 tons. The Navy League had better buy the *Taschenbuch* and—quote it. Ourselves, we fancy that whatever may be true for France and Germany, the sixteen Russian ships of 171,600 tons are more serious on paper than elsewhere. The usual gun tables are given, again with diagrams, from which the superiority of Krupp guns in penetration is made as apparent as any patriotic German can desire; so much so, indeed, that we wonder some of our contemporaries have not already seized on such excellent evidence of British manufacturing degeneration. It is a fine whip for the British manufacturer. As a matter of fact, of course, gun comparisons are hardly possible, and proving-ground penetrations rather indicate how much has been risked to get a high result than anything else. At the same time, very little is really known over here as to the merits of Krupp guns, and some impartial record of their performances would be valuable. Lieutenant Weyer's treatment of the subject is characteristically German, and it is difficult to imagine any publication in this country setting to work to prove British superiority in the same way. Yet the treatment of guns in naval publications probably influences the foreign market largely. Lieutenant Weyer is only one of many instances of how all Germans pull together. Some British journalists might now and again pause to consider whether "patriotism" may not be defined as this, just as much as advertising the superiority of anything foreign. And is the one method any "cheaper" than the other?

Intermediate Practical Physics: A Manual for the Use of Intermediate and Preliminary Scientific Students. By JOHN B. WILKINSON, Assistant Master at Brighton Grammar School. With numerous diagrams, &c. London: Chapman and Hall, Limited. 1902.

THE purport of this little volume is to afford assistance to students, and to act as a kind of key to the questions and problems which are likely to be set at the intermediate and preliminary scientific examination of the London University. The principles of, and the various experiments serving to elucidate their application in mechanics and hydrostatics, are discussed in part. All the most refined and up-to-date methods of measuring and recording lengths, weights, volumes, densities, and specific gravities are fully explained and illustrated. The metric system and French units are employed throughout the work, as is usual in all purely scientific treatises of the same character.

The phenomena attendant upon sound, heat, and light, are next investigated. Especial attention is given to the subject of lenses, and to the experiments whereby the different descriptions can be distinguished and classified. The determination of their respective focal lengths, magnifying powers, and other special features, are demonstrated by suitable diagrams. It must be carefully borne in mind that, in availing oneself of the assistance of all experimental apparatus, a certain amount of practice in the manipulation and working of them is indispensable to success. Until this practical knowledge is thoroughly acquired, it is in vain to expect that accurate results will ensue. It is not asserting too much to state that the success of some of the more difficult and delicate experiments depends almost altogether upon the skill and experience of the operator. Parallel cases occur daily in our hospitals and infirmaries, testifying to the ability of the surgical profession.

In "Magnetism," in Part V., the different modes of magnetising steel bars, comparing magnetic moments and strengths of magnets, determining pole strengths, the magnetic meridian and dip circle, are clearly dealt with. Some useful remarks are added with respect to the difference between the magnetic properties of iron and steel. The subject of electricity is introduced in the closing chapter, including frictional and voltaic electricity. For the determination of the respective electromotive forces of a pair of cells, the author employs the method known as that of "Wiedeman's sum and difference." In all cases where possible, apparatus has been used of so simple a character, that it can be readily made by the student with little cost and labour. This little work will be found a useful adjunct to the operations of the laboratory, and will serve to render the ordinary reading part of the subjects easier, more intelligible, and more agreeable to the student.

SHORT NOTICES.

Sanitary Record Year-book and Diary for 1902. Twentieth annual issue. London: The Sanitary Publishing Company, Limited. Price 2s. 6d.—This work contains a large amount of information useful to all engineers, and more especially so to those whose business includes the construction of sanitary works. We find an able survey of the sanitary legislation of the year 1901, with a discussion of the outlook in this direction for the coming year. Then, in addition to a series of well chosen tables, data, &c., there are lists of those Government offices, both in England, Scotland, and Ireland, which are cognate with the subject, and detailed information concerning sanitary and allied associations, sanitary inspectors' examining bodies, &c. &c.

American Mines Annual, 1902. Compiled by George E. Vigouroux, LL.B. New York City: Geo. E. Vigouroux and Co., 1278, Broadway. Price 5 dols.—This is the first issue of a directory sufficiently indicated by the title. It gives the names and addresses of mines, and in some cases further particulars, as for example, some notes on the size of the plant and the capital of the company. It is well printed.

The Practical Electrician's Pocket-book for 1902. Edited by H. T. Crewe, M.I. Mech. E. London: S. Rentell and Co., Limited. Price 1s. and 1s. 6d.—This little book appears in its fourth edition, which is quite up to the standard of those which have preceded it. It has been revised and brought up to date, and, moreover, has had some additional features added to it, notably in the sections dealing with jointing and testing.

BOOKS RECEIVED.

The Railway Diary and Officials' Directory, 1902. Price 1s.

The Railway Almanac, 1902. Price 6d. London: McCorquodale and Co., Limited.

Protection. The views of a manufacturer. By G. Byng. London: Eyre and Spottiswoode. 1901. Price 3s. 6d.

The Process Year-book, 1901. An illustrated review of the graphic arts. Edited by Wm. Gamble. London: A. W. Penrose and Co.

The Daily Mail Year-book for 1902. Second year of issue. Edited by Percy L. Parker. London: Harmsworth Brothers, Limited. Price 1s.

The Centrifugal Pump, Turbines, and Water Motors: Including the Theory and Practice of Hydraulics. By Chas. H. Innes, M.A. Third and enlarged edition. Manchester: The Technical Publishing Company, Limited. London: John Heywood. Price 4s. 6d. net.

THE INSTITUTION OF CIVIL ENGINEERS.

MEETING OF STUDENTS.

A MEETING of the students of the Institution of Civil Engineers was held at the Institution on Friday evening, the 20th December, Mr. F. S. Courtney, M. Inst. C.E., in the chair, when a paper on "Transmission Dynamometers" was read by Mr. A. M. Morgan. The following is an abstract of the paper:—

In this paper various forms and modifications of transmission dynamometers are described, and some novel designs are introduced, but the author is chiefly concerned with those of a direct-acting character, and especially those belonging to a certain class of dynamometers, in which the displacement of spring couplings effects a horizontal motion of a collar along the shaft. A "torsion-of-shaft" dynamometer is illustrated which is constructed upon this principle.

The working of dynamometers in general is considered in reference to their calibration and accuracy, and also with respect to severe and irregular conditions of working.

The principal features of each form of instrument are separately investigated, and the advantages and disadvantages of its adoption for various kinds of work are considered; the cost of the apparatus, the space occupied, and the attention required being discussed. A comparison is drawn between those which absorb power by directly involving a serious amount of friction and those which indirectly entail loss owing to the action of centrifugal force. In conclusion, the author has entered upon a short discussion on springs and spring couplings, and a few remarks are also made upon recording scales and the gear for operating them, and on taking observations. Finally, the prospect of arriving at a final solution on other lines than those described, namely, by electricity, is discussed.

The reading of the paper was followed by a brief discussion, in which Messrs. A. Bromley Smith, H. M. Warner, J. W. M. Topley, and F. Wright, Studs. Inst. C.E, took part.

THE LONDON AND BRIGHTON ELECTRIC RAILWAY.—We have received a pamphlet, entitled "London and Brighton by Steam and Electricity, 1841 and 1902." Into the merits of the pamphlet we do not propose to enter. There are two drawings in it which are far too funny to escape attention. The first of these is supposed to show the first train running into Brighton, September, 1841. There are two open trucks and the leading end of a closed carriage shown, drawn by two engines of the Stephenson square copper top fire-box type. They appear to have four wheels at each side, the driving wheel being surmounted by another and much larger wheel. No engine at all like this was ever used on the Brighton Railway. The artist has not been less successful in caricature in his view of the Brighton express of to-day. He has taken one of Mr. Billinton's new "Empress" class, fitted it with an extended smoke-box, a huge head light, and a chimney, the top of which must stand at least 18ft. above rail level. There is a colossal cab, and the bogie, instead of being fitted with wheels, appears to be a kind of sleigh. Artists are the first to find fault if a man, a horse, or a tree, are out of drawing. That they should be a little indefinite or "sketchy" is to be anticipated, but there is no excuse for gross inaccuracies. If the artist who is responsible for the drawings under notice had taken the trouble to open his eyes, he would have seen that the Empress class have chimneys little more than 2ft. long—the boilers stand so high; that they have not extended smoke-boxes, nor American head lights, to say nothing of the bogies, which have four wheels.

PROGRESS OF WARSHIPS AND MACHINERY BUILDING IN ENGLAND.

THOSE of our readers interested in the periodical additions made to our own and foreign navies will remember that in our issue of the 28th of last June we gave—under the same heading as this article—our usual *résumé* of the progress made in England in naval constructions in the first six months of the present year. We now supply information as to the similar work accomplished by our principal private builders of warships and their machinery in the latter half of it. Of similar work effected in our Royal dockyards in the same time, we are, with the general public, still kept uninformed by naval authority, but are, happily, able from independent sources to note briefly, in the interest of our readers, what has been done in them.

Giving, as before, priority of place in our record to these establishments, we have to notify that, since the end of last June, there has been no new warship of any class laid down in them; and that only one vessel has been launched, viz., the armoured twin-screw cruiser Essex, built at Pembroke Dockyard, a vessel of 9800 tons displacement, to be fitted by John Brown and Co., of Clydebank, with triple-expansion engines of 22,000 indicated horse-power, designed to give her a speed of 23 knots an hour, 31 Belleville boilers supplying them with steam. The vessel was laid down on January 1st, 1900, and launched at the end of last August.

The vessels in process of "building" in the dockyards are the first-class battleships Queen and Prince of Wales, and the second-class cruisers Encounter and Challenger, at Devonport and Chatham respectively; and the armoured cruisers Suffolk and Cornwall at Portsmouth and Pembroke, particulars of all which vessels as to dimensions, engine power, &c., have been given in previous articles. Of the many ships mentioned in our last as "launched" for some considerable time and "completing," four of them, viz., the battleships Irresistible, Venerable, and Albemarle, all built at Chatham; and the Rinaldo sloop contract built, have been removed into the D Reserve at that dockyard, not ready for commission, as the general public would assume from their being sent into the "Reserve," but to be finally "completed," which often means a "large order," extending over some considerable time. The vessels classed as "completing"—an elastic dockyard term—are the Montagu, battleship, at Devonport; the Drake and Essex, armoured cruisers, at Pembroke; and the Fantome, Espiegle, Odin, and Merlin, sloops, at Sheerness; all of which have been previously briefly described in our pages, but of their actual preparedness for commission or otherwise we are wanting in information.

With reference to the ships enumerated in Lord Selborne's naval programme, made public in the spring and detailed in our article before referred to, none of them has as yet been laid down in our dockyards or given out to private builders for construction, the delay being due to the Boilers' Inquiry, now pending, the decision of the Admiralty being still undetermined on the question of the most suitable steam generator. The difficulty has now, however, we believe, been got over by deferring the orders for the making of the boilers required, contractors having stated on inquiry of them how far they could proceed with the construction of the vessel's machinery independently of their boilers. The Admiralty decision in the matter is now promised at the earliest possible moment.

Turning now to the progress made in England during the past six months by our private builders of warships and makers of their machinery, we are again enabled, through the courtesy of the firms mentioned, to place on record the work accomplished by them.

Taking, then, as in previous similar records, the East Coast shipyards, &c., in order, and coming south, we first note that at Sir W. G. Armstrong, Whitworth and Co.'s works at Elswick-on-Tyne, such progress has been made with the armoured cruiser Lancaster, a vessel of the same dimensions, engine power, &c., as the Essex, that it is expected she will be launched early in the New Year.

The firm next in order of notice is Hawthorn, Leslie and Co., of St. Peter's Works and Hebburn-on-Tyne. The destroyers Greyhound, Racehorse, and Roebuck, in hand for the British Government, and with which good progress had been made at the date of our last record, have since satisfactorily completed their official trials, and been taken over by the authorities. The machinery for the armoured cruiser Kent—one of the County class—building at Portsmouth, has been forwarded to the dockyard, and all the principal parts are on board, the work of erection and completion for trial being now proceeded with. The engines for the Lancaster, previously mentioned as building at the Elswick shipyard, are now being erected at the St. Peter's Works, and will be ready for the vessel when launched. The whole of the material for the machinery of the armoured cruiser Cornwall, building at Pembroke, is also at the works, and the construction of her engines will follow on those of the Lancaster.

The financial difficulties of Earle's Shipbuilding and Engineering Company at Hull have resulted in the complete closing of the establishment to warship work, the contracts in hand by the late firm on Government account having now been taken over for completion by the dockyard engineers. The shipbuilding yard and engine works of Earle's Company having now passed into the hands of Mr. C. H. Wilson, M.P., the noted Hull shipowner, no warship work will be dealt with therein.

After leaving Hull, there is nothing doing in warship building until the Thames is reached, where, at the Thames Ironworks Company's yard at Blackwall, since our last report, the first-class battleship Cornwallis has been launched—on July 17th—and is now lying side by side with her sister ship, the Duncan, by the same builders, in the Victoria Docks, where both are making good progress; the main engines and boilers of the Duncan—made at the company's engine works at Greenwich—with her masts and funnels being all in place, with all auxiliary machinery and principal pipes fitted. The Cornwallis has her main engines and boilers in place and completed, the latter with the exception of the brickwork, most of the auxiliary machinery being also in place on board. Of the machinery, &c., for the battleship Albemarle—built at Chatham—making by the same firm, one set of the main engines is being dismantled in the shops at Greenwich for transit to the dockyard; and the second set is being erected in the works. One-third of the boilers—Belleville type—for this ship have been delivered on board, and fixed in place, while the main and auxiliary condensers, and nearly all of the auxiliary machinery, have reached the ship.

At Yarrow and Co.'s new works at Poplar, the two shallow draught British gunboats Teal and Moorhen have been completed and shipped in floatable sections; and the eight Yarrow water-tube boilers under construction for the third-class cruiser Medea are well in hand, as four of them will be completed by the end of the year. The 31-knot destroyer Akatsuki, built for the Japanese, has been handed over to their Government, and will shortly proceed to Yokohama; her sister ship Kasumi being expected to leave this country about a month later. On the official three hours' trial of the first-mentioned vessel, which took place on November 21st at the Maplin measured mile, the mean result of six runs gave a speed of 31·3 knots an hour, the mean revolutions of the engines being 404 per minute, and the indicated horse-power developed 6450. Yarrow and Co. have also in hand three of their patent water-tube boilers for the Russian Government, which are on the point of completion.

At Humphrys, Tennant and Co.'s works at Deptford Pier rapid progress is being made with the machinery for the armoured cruisers Berwick and Suffolk—building at Glasgow and Portsmouth respectively—both having engines of 22,000 horse-power, to be supplied with steam by Niclausse water-tube boilers. The completion of the armoured cruiser Drake, built at Pembroke, with engines of 30,000 horse-power, made at the Deptford Pier works, is now proceeding satisfactorily, and she will be ready to leave the Haven about the end of next February.

The firm of Maudslay, Sons and Field, of Lambeth, having ceased work, the contract work in hand for the Government at its final suspension has been taken over for completion by the Dockyard engineers.

John I. Thornycroft and Co., at the Chiswick yard and works, in the past six months, have completed and put through their trials the two first-class torpedo boats Nos. 107 and 108, built for the British Government, thus completing the four on order, which have all a speed of 25 knots an hour, and carry a load of forty-two tons. All have now passed into the service. An order for four more of this class of boat has recently been received by the firm for the Government; they will be laid down before the end of the year. They will closely resemble those mentioned above, but will be of slightly larger dimensions, the speed and load carried remaining the same. Two 31-knot torpedo boats for the Japanese Government are nearly complete.

At the Birkenhead Ironworks, Laird Brothers since June last have floated out of the building dock to an adjacent one the first-class battleship Exmouth, where her machinery will be put on board. The 30-knot destroyers Lively and Sprightly, built for the Government, have been delivered at Devonport Dockyard, and a set of water-tube boilers of the Laird type has been delivered for the third-class cruiser Blonde. Good progress is also being made with the fitting on board at Devonport of the machinery made by Laird Brothers for the first-class battleship Montague. The two 30-knot destroyers for a foreign Government have also been launched, and are well forward towards completion at the Birkenhead Works.

A BIG DUPLEX LATHE.

WE illustrate on page 654 a large duplex lathe which Hulse and Co., Limited, Ordsal Works, Salford, Manchester, have recently completed, and which is specially adapted for dealing with crank shafts of the heaviest kinds, but is also suitable for turning large forgings and castings.

The lathe in question admits 9ft. in diameter and 27ft. between centres, being so arranged that the four cutting tools, viz., two at the front and two at the back of the lathe, may be in operation simultaneously. The sliding carriages are independent of each other, and may be not only traversed at different rates of feed, but any one or more may be surfacing whilst the others are sliding, or *vice versâ*, and these in either direction.

The bed, which is about 43ft. long, is of massive construction, consisting of four longitudinal box girders in pairs, united by numerous transverse box bars. Between each of the longitudinal girders a long non-rotating steel guide screw is placed, by means of which the back and front carriages are respectively traversed longitudinally without cross straining.

The fast headstock is quadruple geared and has thirty-two changes of speed uniformly graduated, and which may be readily effected; the face-plate chuck, which is 9ft. in diameter, is of great strength and externally geared on the back, fitted with four cast steel jaws and independent screws. The spindle is of steel with hard gun-metal adjustable bearings of square outline, the back bearing being multiple-grooved for resisting the end thrust without undue friction. The movable headstock is fitted with a large steel cylinder actuated by worm wheel for forcing the centre into the work, and by hand wheel direct on the screw for quickly moving in or out, and is adjustable along the bed by worm and wheel and by rack and pinion.

The four sliding carriages are each fitted with a rotating nut, reversing gear, swing frame, and change wheels, these latter not only imparting the various rates of feed longitudinally for sliding, but also transversely for surfacing; constant feed motion and feed traverses for both sliding and surfacing are obtained by means of vertical and horizontal steel shafts, and bevel gear from the fast headstock.

Two compound rests and two narrow rests are fitted for turning crank-pins and inside webs, one of each kind being interchangeable between the two front carriages, and one each between the back ones, the compound rest at the back having an inverted vee in order to resist the upward pressure of the cut. The lathe is arranged to be driven from a counter-

shaft by an electric motor, a separate motor being provided for the quick power traverse of the sliding carriages along the bed.

The lathe in question is very massive and well proportioned, and weighs about 98 tons.

RAILWAYS AND STEAM TRAMWAYS OF THE DUTCH EAST INDIES.

THE International Colonial Institute, whose headquarters are at 36, Rue Voydt, Brussels, has had a number of papers presented on the subject of railways for colonies and new countries. Among these is a somewhat lengthy report on the railways and steam tramways of Java and Sumatra by Mr. J. W. Post, formerly engineer of the State Railways of the Dutch East Indies.

Railways of Java.—In Java the railways are operated by and have been built by the State. The first line was opened in 1878, and the aggregate length is now about 1086 miles. The standard gauge is 3ft. 6in., increased from 0·16in. to 1in. on curves, while the super-elevation of the outer rail is from 0·88in. to 3·60in. The gradients are from 1 in 200 to 1 in 40, with a maximum of 1 in 25 in rough country, the gradients being compensated for curvature. The curves are from 1312ft. to 492ft. radius. The largest tangent is 13 miles. The permanent way is laid with 50 lb. flange rails, 33·45ft. long, on sleepers of native djatti wood, not treated. These weigh about 123 lb. each. There are twelve sleepers per rail on tangents, and fourteen on sharp curves. The rails are laid with suspended joints, spliced with angle fish-plates. A new joint is also being tried, in which the plates have webs projecting below the rails, and gripping the edges of the rail flanges, and of a base plate of T-section bolts pass through these lower webs.

There are no less than eighteen types of locomotives, nine on the eastern and nine on the western division. The weight in working order ranges from 14½ to 33½ tons, with 10 to 25½ tons on the drivers, and maximum axle loads of 9 tons. The train loads are from 15 to 50 wagons, or 88 to 324 tons; double-headed—or two-engine—trains being run on the heavy parts of the lines. The fuel is mainly coal from the mines in Sumatra, which are operated by the State. This costs about £1 6s. 8d. per ton at Java ports. Welsh coal from England is also used, and the use of petroleum refuse is being considered.

To facilitate the passage of carriages and wagons around the curves, different systems of running gear have been adopted. First, four-wheel bogies; secondly, two-wheel bogies; thirdly, the Kiebitz system, with two axles; fourthly, the Cleminson flexible wheel-base system, with two and three axles. The maximum rigid wheel base is 14½ft. The eight-wheel bogie wagons are of 20 tons capacity, and the four-wheel wagons of 8 tons capacity. The metal parts of the cars are imported from Europe, the wooden parts are of native djatti wood, and the erection and finishing are done by native and Chinese labourers in the railway shops. The passenger carriages seat from 16 first-class to 100 fourth-class passengers. This latter class exists only on the line from Batavia to the port, and is for the coolie labourers. The carriages are on the American system, with centre aisles and end platforms. The roof is double, or on the monitor plan, for ventilation. The windows can be closed by glass sashes, sun screens, or wire blinds. Special carriages for the Batavia and Sourabaia service, 568 miles, carry 6 to 8 first-class and 12 to 17 second-class passengers; these have a toilet room, and the seats can be converted into beds, three seats making two beds. The maximum speed is 15½ to 25 miles for mixed trains, and 20 to 37 miles for passenger trains. Automatic central couplings are used, with double safety chains.

The bridges have mainly superstructures of iron or mild steel on masonry piers, though for very high spans metal piers or towers are used. The bridges are of rolled steel joists for spans of 6½ft. to 16½ft.; plate girders, 20ft. to 33ft.; trusses, 40ft. to 262ft. Spans of 32·8ft. to 39·6ft. are usually erected at the railway shops. Larger spans are built on false-works, or on the ground near the site, being moved into place by rollers. One viaduct 530ft. long—continuous girder—in three spans, with a height of 210ft. above the water, was built in line with the piers and then launched endways, the end being temporarily fitted with a special triangular girder sent from Europe. The masonry is largely of native bricks, with hard burned bricks from Holland to carry the imported cut stone bridge seats. The rains and the irrigation system make it necessary to provide numerous culverts and waterways.

The less important buildings are of bamboo, roofed with palm leaves. The main buildings are of stone, brick, and wood, with roofs of native tiles or imported galvanised sheet iron. As far as possible native material is used. The employés are mainly natives, but Chinese coolies are employed for hard work, such as rock cuttings, tunnels, &c., and many of them are also carpenters, painters, &c. The trade schools of Java are supplying skilled labourers and foremen. The operating staff, enginemen, conductors, &c., are nearly all natives, and many of the minor officers are Indo-Europeans. The aim is to replace Europeans by natives as far as possible, which gives economy and general satisfaction. For the construction work in thinly-populated districts convicts are employed as labourers, drivers, masons, blacksmiths, bridge builders, &c.

For new lines a preliminary survey or reconnaisance is first made to establish a possible route, and upon this an estimate of maximum cost is based. When the Government has voted the necessary appropriation, a definite location is made. The estimates are rarely exceeded, and, in fact, there is often a surplus remaining. There are good topographical maps of a large part of Java, on scales of 1 to 100,000, and 1 to 20,000—the latter having contour lines 32·8ft. apart. No definite limit is prescribed as to the gradients and curves; but the location is left largely to the discretion of the engineer, who also exercises his judgment as to the adoption or avoidance of tunnels or other heavy work. The gauge is fixed at 3ft. 6in., however, and the engineer is instructed to consider the maximum gradients and curves of the existing line with which the new line is to connect. Rapidity of construction is considered desirable; but the general principle is to obtain lines of minimum cost, with due regard to the permanent cost of operation and the interest on cost of construction. The average cost of construction is about £9300 to £12,000 per mile. The operating expenses are about 58 per cent. of the gross receipts.

The island is covered with a network of good roads, which are in general better maintained than most of the roads in Europe. All material that can be carried in buffalo or ox carts can therefore be hauled ahead, and bridge piers, culverts, &c., built ahead of the line. The heavy bridge work, however, must await the laying of the track, and temporary timber trestles are often built to hasten the completion of the line, and to serve afterward as false-works for the steel superstructure.

There are only about twenty miles of double track. The operation is controlled by telegraph orders, and there are target and semaphore signals, with interlocking plants at several junctions. On some of the lines trains are required to stop at all crossings—as on secondary railways—thus avoiding the expense for gates and watchmen. As the sun rises and sets at six o'clock, there is as little traffic as possible between 6 p.m. and 6 a.m. The railways have been built mainly for economic reasons, and have aided greatly in developing native agriculture and foreign commerce.

Railways of Sumatra.—The railways have been built and are all operated by the State. The first line was opened in 1891, and there are now about 150 miles of railway. The standard gauge is 3ft. 6in., widened 0·24in. to 0·96in. on curves of 3280ft. to 492ft. radius. The maximum gradients are 1 in 166 to 1 in 33 on adhesion lines, and 1 in 20 to 1 in 12½ on the rack-rail sections. The rate of gradient is reduced 0·6 per cent. on curves of 492ft. radius to 0·1 per cent. on curves of 1640ft. Grade intersections are laid out with vertical curves of 3280ft. radius for rack-rail sections, and 8200ft. to 16,400ft. on adhesion sections. The sharpest curves are of 492ft. radius, with transition curves 65·6ft. long; the length diminishing to 32·8ft. for curves of easier radius. Between reverse curves a tangent of 98·4ft. is interposed. The rails are of flange section, 50¾ lb. per yard, 21·96ft. long. Rails of 80 lb. per yard, 4·08in. wide and 5·52in. high, are laid for 1·55 mile on one line, where coal trains descend a gradient of 1 in 33 with brakes applied. There is also a tunnel on this section 2650ft. long, where there is more or less corrosion of the rails, and the use of the heavy section reduces the work of maintenance. The cost of construction has averaged £12,900 per mile.

The rack rail is of the Marsh type, having teeth riveted between two steel channels set back to back. The first racks had trapezoidal teeth, but they are now made with round teeth, which can turn in the channels. The rack weighs 114 lb. per yard, and is made in lengths of 17·38ft. To prevent accidents from a cog of the engine wheel striking a tooth of the rack as the engine enters the rack section, the end of the rack is mounted on springs, and has its teeth gradually planed down.

The sleepers on the adhesion and rack-rail sections are of the well-known post type, rolled with a varying thickness. Those for the rack rail weigh 86 lb. and the others 83 lb. each. Sleepers of djatti wood from Java are laid for about 16 miles. The rails are attached to the steel sleepers by bolted clamps. The weight of the ordinary permanent way is about 210 lb. per yard, or 374 lb. for the rack-rail track. The cost, delivered at Port Emma, is about 13s. 6d. per yard for the former and £2 for the latter, or 10s. and £1 12s. 6d. respectively at the works in Europe. Plate-laying can be done by native labour at the rate of 3280ft. to 4920ft. per day, or 984ft. to 1312ft. of rack-rail track. The use of steel sleepers was commenced in 1888. The permanent way is in excellent condition; the cost of maintenance is very small, much less than where the wooden ties are used, and the cost of renewal is almost nil. There are eight sleepers per rail on the adhesion and nine on the rack-rail section.

There are sixty locomotives in service, including two types of adhesion engines and four of combination adhesion and rack-rail engines. All are tank engines, with four or six adhesion driving wheels, the largest being 34-ton adhesion engines and 29½-ton rack engines. The former have six coupled wheels and a two-wheel leading bogie, and they will haul train loads of 250 tons at 15½ miles per hour on gradients of 1 in 83, or 60 tons at 12 miles an hour. The heaviest rack engines take trains of 40 tons ascending and 48 tons descending gradients of 2 in 12½ at speeds of 10 and 12 miles per hour respectively. None of the rack engines have more than one cog-wheel, and these engines are always on the down-hill side of the train. All the engines have hand, steam, and air brakes. The fuel is coal from the State mines, costing 8s. 9d. per ton at the main station.

There are sixty-five passenger carriages of seven types, and 377 goods wagons of ten types. They have either two rigid axles or four-wheel bogies. The 20-ton double-bogie coal wagons are made with the bottom sloping from the centre to each side, and the lower parts of the sides are hinged to swing outward and upward. These wagons are of steel, and are used to supply the bins of the coaling station at Port Emma. There are also four-wheel hopper-bottom wagons which are used for coaling ships at the port. These are loaded from the spouts of the coal bins, and run out on a steel pier having chutes at the end, down which the coal is discharged into the ship's hold or bunkers. Hand brakes are used, and the centre coupling is a combination automatic coupler and spring buffer. The passenger carriages are of the American type, and have double roofs on account of the heat; the upper roof is of galvanised corrugated iron. There are only two classes of passengers. The speeds of passenger trains are 16 to 22 miles per hour.

Bridge abutments and piers were usually built in advance of the road bed. Steel bridges of 32·8ft. to 39·36ft. span were mainly erected at the workshops at Padang. Temporary wooden structures of pitch pine from Pensacola, U.S.A., were frequently built in advance of the steelwork. This timber is much cheaper and lighter than the native djatti. Numerous culverts and waterways have been provided, including pipe and open culverts and pipe syphons. The largest structure is a steel arch bridge, with steel columns rising from the arch to support the floor system. This has a span of 183·68ft., a rise of 59ft., and the rails are 118ft. above the river. The masonry is generally of stone; brick is also used, particularly for stations and other buildings. As the native tiles are of poor quality the roofs are mainly of galvanised corrugated sheet iron, or of palm leaves for the less important buildings. As the supply of good timber is limited, steel is used for permanent way and rolling-stock construction, bridges, shops, coaling stations, telegraph and signal posts, track signs, &c.

The Malays of Sumatra are not used to hard work, and it was necessary to import coolies from China and Java. The natives are now, however, beginning to work on the railways, generally under a Chinese foreman or sub-contractor. At the shops the head officers and some foremen are Europeans; the other foremen are Indo-European, while the labourers are Chinese and natives. The locomotive enginemen and firemen are natives from Java. The chief engineer has under him a master mechanic and a technical and executive staff. Division and assistant engineers are in charge of the different parts of the line. The Government employs about 500 native convicts on the works.

The lines are all single track, and are operated by telegraph orders, trains stopping at all crossings so as to reduce the expense for watchmen, &c. On the adhesion lines there is never more than one train between two stations. On the combination adhesion and rack lines trains may follow each other at ten-minute intervals, but the space between trains must not be less than 1640ft. There is very little traffic during the hours of darkness—that is, from 6 p.m. to 6 a.m. The most important traffic is the hauling of coal from the State mines to the coaling station at the port.

Steam tramways.—In the Dutch East Indies there are light railways of low speed and low cost of construction which belong to the type of line known in Europe as steam tramways. There are about fifteen to twenty of these lines, aggregating nearly 650 miles—8 miles double track—with 183 locomotives, 303 passenger cars, and 1139 freight cars. The shortest, 9½ miles, is a suburban passenger line. The longest, 165½ miles, makes 75 per cent. of its revenue from goods traffic. Lines of the latter class, opening up the interior of the country, have been of great advantage in the development of resources and trade. Each line has certain features of its own in regard to traffic. All the lines are built by private capital, under concessions from the Government, which reserves the right of purchase after the expiration of the concession. The gauge is 3ft. 6in., with two exceptions:—First, the 6ft. gauge of the Batavia line, 8·68 miles, operated by "fireless locomotives"—Lamm-Francq steam storage system. Secondly, the 4ft. 8½in. gauge of the Djoega-Brossot line, 16¾ miles. The flange rails are 42 lb. and 50 lb. per yard; an 18 lb. rail tried by one company proved a costly investment, and had very soon to be replaced with 38 lb. rails. There is an electric railway in Batavia, and oil-burning engines are proposed for a 20-mile line in the Solo district of Java. The War Department operates in Sumatra a steam tramway of 30in. gauge, 40 miles long, which was built for strategic purposes, but is used for public traffic—passenger and goods. In addition to all these, there are a number of private lines, generally on large plantations, and connecting with the public lines. Notes of some of the public steam tramways are given below.

Samarang Joana (Java).—The concession allows the use of the land at the side of the main road, or even of the road itself providing a width of 11ft. be left clear. Existing bridges and viaducts may also be used, if strengthened as required. The gradients are 1 in 100 to 1 in 72, and the sharpest curves 328ft. radius for main line, and 164ft. for spurs. The rails weigh 42 lb. and 50 lb. per yard. The sleepers are of djatti wood, eleven to a rail length of 29·52ft., or thirteen on sharp curves. Base plates are used at joints, and on some intermediate sleepers on curves. Angle fish-plates of Z-section are used. The cost of the road was £2300 per mile. There are two types of locomotives—13-ton engines with four driving wheels and 6ft. rigid wheel base—are employed on level lines; 18½-ton engines with six driving-wheels and 6·56ft. wheel base are employed on the heavy lines. The former will haul trains of three passenger carriages, one luggage van, and eight goods wagons of 8 tons capacity. The latter are designed to haul, at 7½ miles an hour, two carriages, one van, and five goods wagons on gradients of 1 in 50. The wagons are built of steel and mounted on four wheels, but there are some 12 and 16-ton wagons on four-wheel bogie trucks. The passenger carriages are also mounted on bogie trucks. Djatti wood refuse, coal, and petroleum refuse are employed as fuel. The maximum speed is 10 miles per hour. Numerous bridges and waterways are required, including pipe culverts and open culverts, with masonry walls spanned by rolled steel joists. Plate girder bridges are also built. The total length of the line is 165·5 miles, comprising 7·8 miles of city street railway, 62·1 miles of main line, and 103·4 miles of branches. The first piece of line was opened in 1882.

East Java Tramway.—This system, 50 miles long, includes a city and suburban line as well as country and industrial lines. The permanent way is very similar to that of the line above described, but has only ten sleepers per rail length. The cost of construction averaged £2506 per mile. The passenger engines weigh 9 tons and have four coupled wheels; they haul a maximum train load of four cars. The goods engines have also four coupled wheels, but weigh 13 tons, and haul thirteen wagons of 8 tons capacity. Most of the wagons have four wheels, but the 16-ton goods wagons and the passenger carriages are mounted on four-wheel bogie trucks. On part of the line there is telephone connection between the stopping places.

Serajou Tramway (Java).—The maximum gradient is 1 in 80, and the sharpest curves are of 492ft. radius. The line is laid with 51·4 lb. flange rails, 33·4ft. long, with twelve wooden sleepers per rail length. The joints are spliced by angle plates. The locomotives have a weight of 20½ tons, equally distributed on three coupled axles with a wheel base of 8ft. The goods wagons are of 8 and 16 tons capacity, on four and eight wheels respectively. Coal and wood are used for fuel. The steep gradients were adopted in thinly-populated districts to enable the line to follow existing roads, and the bridges on this part of the line were cheaply built, so that the line might be economically reconstructed on a new location in the future. The operation is controlled by telephone, instruments being placed at crossings and stopping places.

Samarang-Cheribon Tramway (Java).—This line is 165 miles long, and it is very similar to the foregoing. The 16-ton engines can haul on the level a maximum train load of fifteen goods wagons of 8 tons capacity. Coal and djatti wood are used as fuel. All the rolling stock has steel frames, and the average train consists of two passenger carriages and four goods wagons. The cost of construction was about £3260 per mile, exclusive of rolling stock and expenses involved in obtaining the concession. The traffic is operated by telegraph between the four main stations, the intermediate stopping places being connected with these stations by telephone.

CRYSTAL PALACE ENGINEERING SCHOOL.—The "Wilson" premium for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to S. J. N. Carrington, for his paper on "The Widening of the Brighton Line between Balham and Croydon." Other papers read during the term were "The Eastbourne Pier Improvement Works," by J. M. Attlee; "Trade Unionism," by F. H. H. Williamson; and "Modern Electricity," by E. A. A. Parsons. The premium was presented to Mr. Carrington by Col. Raban, R E., Director of Works to the Admiralty, on the occasion of the eighty-seventh distribution of certificates at the above school, on December 20th.

THE WING PROPELLER FAN.

WE were asked some little while ago to witness at the works of F. W. Potter and Co., of Phipp-street, Great Eastern-street, certain tests of propeller fans, among them the Wing fan made by this firm. Special apparatus had been fitted up for these tests. A tube of thin sheet iron 18ft. long and 27in. in diameter had been constructed, and was placed horizontally with its axis some 3ft. from the ground. At one end it was slightly flanged, the opening left being such as just to admit of a 25in. fan revolving in the orifice. On a bench of requisite height was secured a small shunt-wound electric motor, which had its spindle lengthened to such an extent that fans of different makes and sizes could be readily slipped on and clamped to it. Some little way into the tube were placed at right angles to one another two thin sheets of metal. It was explained that these were for the purpose of preventing eddy currents, and to render the readings of some of the fans more easy to take. It was stated that this if anything favoured the fans against which the Wing fan was being tested, since some of these, so it was said, set up some exceedingly wasteful eddy currents. About 18in. from the end of the tube remote from the fan was hung a light circular disc, two fine strings being secured to it and to hooks in the ceiling for this purpose. This thin screen could be readily moved, and quite a light touch would set it swinging. Attached to its middle was a string, which was taken in a horizontal direction to a pulley

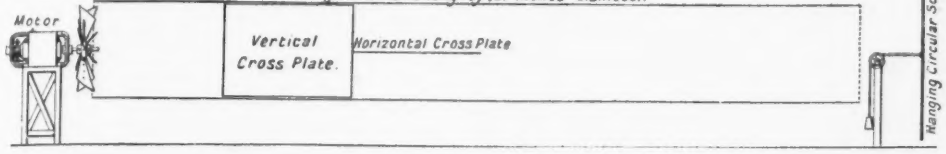


Fig. 1—TESTING APPARATUS

placed at the right height. The free end of the string was provided with a wire hook, on which weights could be hung. The apparatus employed is shown diagrammatically in Fig. 1.

The method of testing was as follows:—A propeller fan was mounted on the motor spindle, and placed so that it just entered the tube. Potter and Co. informed us that they had made a very large number of experiments as to the position in which all fans gave the best results, and that it had been found that the best results were obtained in all cases when the fan blades just entered the tube. The motor was then started, and the volts and ampères read by means of instruments. The action of the fans caused air to travel through the tube and to impinge upon the light screen, which, we may say, was about 4ft. in diameter. The air caused the screen to be moved away from the tube and then weights were hung at the end of the string, already alluded to, until the screen was kept in its central position, *i.e.*, hanging vertically as though no air were blowing.

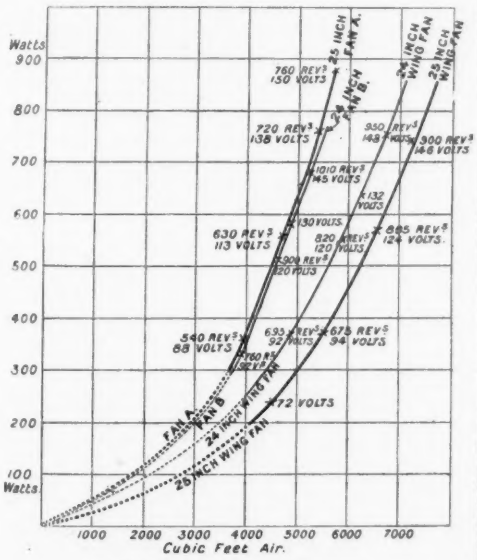


Fig. 2—DIAGRAM OF RESULTS

The following readings were taken with a propeller fan of a well-known maker, which we shall call fan A, and with a Wing fan, both fans being 25in. in diameter:—

Name of fan.	Speed.	Current in ampères.	Volts.	Watts.	Weight on end of string.
Fan A	760	6·00	150	900·0	4·0 lb.
Wing fan	910	5·25	146	766·5	6·5 ,,
,,	650	4·25	102	433·5	4·0 ,,

We were informed that the whole current going to the motor was being measured by the ammeter, and that the volts were taken across the motor terminals. It will be seen from the table that the Wing fan required less energy to drive it, so that the screen was deflected with greater force than in the case of fan A, and that, as a fact, to produce the same effect on the screen the Wing fan required rather less than half the energy to be supplied to the motor. It will be observed that in the first reading of the Wing fan the speed is higher and in the second reading lower than the speed of fan A. The governing arrangements of the motor and the power of the motor itself would not permit of any higher speed being got out of the motor with fan A on it. It was running to its fullest capacity. Moreover, the regulating resistance was not sufficiently divided up to always get the exact effect required, as will be seen from the next readings, which were made with another type of fan by another well-known maker, which we will call fan B. In this case both the fans were 24in. in diameter, and were mounted on the motor shaft in precisely the same way as in the readings already given. The following results were obtained:—

Name of fan.	Speed.	Current.	Volts.	Watts.	Weight on end of string.
Fan B	1060	4·75	146	693·5	3¾ lb.
Wing fan	—	4·0	98	392·0	3½ ,,
,,	—	4·4	118	519·2	4⅛ ,,

Here, as will be seen, it was found impossible, owing to lack of regulating capacity, to make the Wing fan act on the screen with such a force that 3¾ lb. exactly balanced it, as in the case of fan B, so that the next possible readings above and below it were taken. It will be observed, however, from the second reading with this fan that even when acting on the screen with a force requiring ⅛ lb. more to balance it, the Wing fan was absorbing 174·3 watts less than fan B.

Potter and Co. inform us that they have connected the action of the air on the suspended screen with the volume of air in cubic feet passed through the tube, and have supplied us with the accompanying diagram—Fig. 2—from which they have worked out the following tables. The motor is stated to have an efficiency of between 50 and 60 per cent.:—

TABLE I.—*Volumes of Air.*

	24in. Wing.	25in. Wing.	Fan A.	Fan B.
(1) 4500 cubic feet of air requires, watts	520	240	490	470
(2) 5500 ,, ,, ,, ,,	485	375	780	750

TABLE II.—*Power used.*

	24in. Wing.	25in. Wing.	Fan A.	Fan B.
(1) 350 watts move, cubic feet of air	4700	5350	3900	4000
(2) 550 ,, ,, ,,	5850	6500	4700	4750
(3) 700 ,, ,, ,,	6500	7300	5250	5300

We also saw the pressures set up in the tube with the end open and with the end closed, but the apparatus was only of a rough-and-ready kind, and difficult to manipulate. The readings, therefore, were not of much value, but such as they were they went in favour of the Wing fans.

The claim put forward by the makers is that the Wing fan for a given amount of power will move a greater volume of air than any other propeller fan in the market. The experiments shown to us certainly appeared to prove that this claim is upheld so far as the two fans which we saw tested, and the special conditions of the test, were concerned. For obvious reasons, we do not mention the names of the makers of these fans.

For a considerable time now, Potter and Co. have been carrying out systematic experiments on propeller fans,

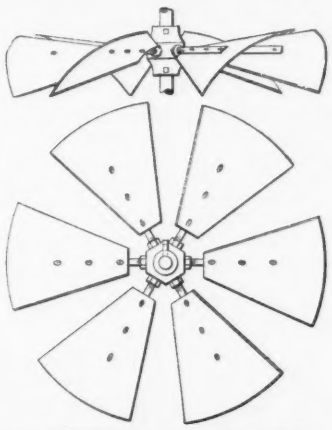


Fig. 3—THE WING PROPELLER FAN

especially with reference to the angle and curvature of the blades, and the methods of fixing them to the central boss. They have found that an angle of from 27½ to 30 deg. is the best all-round angle for combined output and efficiency. The fans which we saw under test had their vanes placed at an angle of 30 deg. The accompanying illustration—Fig. 3—shows the moving portion of the fan, the shape of the blades, and the methods of mounting them.

RUSSIA'S MERCANTILE MARINE.

THE Russian Ministry of Finance has just published an interesting book dealing with the position of the Russian mercantile marine on January 1st (14th), 1901. According to the official lists of ships at the beginning of this year, Russia possessed 745 steamships and 2293 sailing vessels, with a combined carrying capacity of 633,820 tons, of which 57½ per cent. are steamers and 42½ per cent. sailing vessels. In the northern waters, that is, in the White Sea and in the Baltic, the sailing vessels exceed the steamers both in number and in carrying capacity, while in the southern waters, in the Caspian and Black Seas, the steamers take the lead in both respects to tonnage, although they are exceeded in number by the sailing vessels. Most of the steamers added to the lists in the course of 1900 belong to the Baltic and the Black Sea, and the increase of the two mercantile fleets was 38 steamers, with a total registered tonnage of 35,193 tons. The increase of steamers on the White and Caspian Seas was far behind that just quoted, for it amounted only to 8 steamers with a total registered tonnage of 1803 tons. Judging from figures, the increase of the sailing ships seems to be greater; 96 vessels, of a total carrying capacity of 10,213 tons, were added to the Baltic shipping, while the sailing ships of the Black Sea in 1900 were fewer by 24 than in 1899.

The ownership of the steamers is distributed as follows:—59 per cent. of the tonnage belongs to shipping companies; 21·9 per cent. to individual owners; 16·9 per cent. to trading firms and shipping firms; and the residue of about 3 per cent. belongs to the State and Ministry of Ways of Communications. As steamship owners the first place is held by the shipping companies in the Black and Azoff Seas, but on the Caspian Sea it is the individual owners who come to the front. The vessels and tonnage of the leading Russian shipping companies are as follows:—

	Steamers.	Tonnage.
The Russian Steam Navigation and Trading Company	72	67,654
The Russian East-Asian Steamship Company	3	12,618
The Russo-Baltic Steamship Company	5	7,896
The Archangel and Murman Company	13	6,223
The Orient Transport Company	25	13,703
The Caucas and Mercury Company	30	11,934

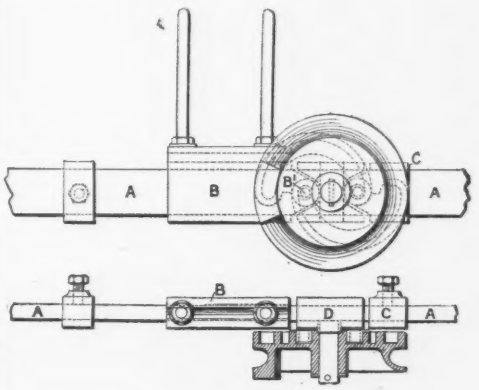
The last-named company is engaged in carrying cargoes mainly on the Caspian Sea. In the Russian Report the above list of shipping companies is closed by the steamers belonging to the so-called "Volunteer Fleet," which is the second largest company; but it is certainly not right to class these steamers as belonging to private companies, for they ought to be classed as steamers owned by the Russian Government.

The details concerning the value of the Russian mercantile marine and its sources of origin are of some interest. The total value of the steamers on January 1st (14th) of this year is given as being 104,500,000 roubles, or about £11,000,000. Of this total 51 per cent. is in the fleet in the Black and Azoff Seas, and 35 per cent. is represented by the steamers on the Caspian Sea. The passenger steamers are first in value, for they represent 32,300,000 roubles, and then follow the tank steamers to the value of 27,300,000 roubles, and the mail and passenger steamers to the value of 17,000,000 roubles. How backward Russia is still in shipbuilding is well seen in the returns as to the origin of its mercantile marine; thus, 73 per cent. of the vessels and 82 per cent. of their tonnage are built in foreign shipyards. There is thus great scope for Russian enterprise in this direction. The increase in the number of Russian steamships has been rather remarkable of recent years, for 354 steamers, or 47 per cent. of the total number, have been built during the last ten years, and of these 354 steamers, 203, or 57·4 per cent., were built during the last five years.

The number of Russian sailing ships is 2293. But, as more than 69 per cent. are under 100 tons capacity, a great many craft cannot be taken into account. The total value of the fleet of sailing vessels is estimated to be 1,603,248 roubles, and this is inclusive of the valuable tank-sailing vessels used only on the Caspian Sea. Nearly all the sailing vessels of the Russian mercantile marine are built in Russian yards, and only a very small percentage of them is of foreign construction.

CAM BELT STRIKER.

THE drawing below illustrates a duplex cam belt striker made by the West London Engineering Works, Chiswick. It consists of a rolled bar A, on which slides the block B with belt fork. On another sliding block a wheel, which has two spiral channels cast on its back, is mounted. On an extension of B there is fitted a small roller fitting one of these



channels. Another roller on a fixed block C fits the other channel. When the wheel D is rotated by the hand chain, the fork is moved to right or left by twice the distance that either cam would give alone, because the centre of the wheel is moved at the same time. The action is quite clear from the drawing, and it will also be evident that the gear is self-locking. It works smoothly and well, and is constructed in such a manner as not to be much if any more expensive than more usual forms of belt strikers.

FLOATING DOCK AT ODESSA.—The Russian Steam Navigation and Trading Company has recently erected a new floating dock at Odessa, and we understand it has since been regularly employed. The total length of the dock is 381ft., breadth over all 80ft., with a clear breadth between side walls of 63ft., draught 20ft., with a lifting power of 5000 tons. The facility and rapidity with which vessels can be lifted, painted, and lowered, combined with a most reasonable tariff, will naturally commend the dock to the favourable attention of British and other owners. The need of dry dock facilities at this port has been felt for some time past, and the advantages of this new dock were demonstrated recently, when the s.s. Sviatoi Nicolai, proceeding from the harbour to the dock, fouled an anchor, which got jammed between a propeller blade and her stern frame, thus disabling her. Had there been no dry dock available at Odessa, it would have been necessary to have towed her to Sevastopol, which would have incurred delay and heavy expense. Large and commodious engineering works are now in course of construction alongside the dock, so that early in the New Year a modern fully equipped establishment will be at the disposal of shipowners.

GERMAN CRUISER KÖNIG WILHELM ERSATZ.

SOME time ago we illustrated and described in THE ENGINEER the German armoured cruiser Prinz Heinrich, and pointed out how greatly she advanced upon the Fürst Bismark, her predecessor. Though externally less visible, almost as great an improvement exists between the latest vessel and the Prinz Heinrich. Of the new 9048 type there are two vessels, substantially similar, under construction—the Prinz Adalbert and the, as yet unofficially unnamed, König Wilhelm Ersatz.

The table below indicates the progress in armour, armament, machinery, &c., in the three types, but attention may also be drawn to other changes. Not one of the least interesting of these is the form of rudder and cut-away dead-wood. For the rest we may observe that, as evidenced by the now well-known Fürst Bismark, earlier German construction was—in a sense—essentially "amateur;" that is to say, recently completed ships embody those kind of features which we might expect to see evolved by the gentlemen who contribute to our daily Press those awe-inspiring lists of comparative fire-energies and the like. The Bismark's guns are heavily protected, while their bases are nearly ignored; in later vessels much is discarded in favour of protected gun bases, and in place of five distinct partially-defended gun positions, there are now but three groups, each completely protected. The Bismark is more or less at the mercy of all shell, though proof against anything but the largest A.P. projectiles. The new ships can be successfully attacked by merely 8in. A.P., but they are shell-proof—undoubtedly the better virtue of the two. "Increase the armoured area at all costs" seems to be the motto of modern German design, and unquestionably this is correct.

The data of these cruiser designs are as follows. We have added a few others for comparison:—

Name	Bismark.	P. Heinrich.	P. Adalbert and new ship.	Japanese Iwate.	British County class.	U.S. St. Louis.	French Montcalm.
Displacement, tons	10,700	8,980	9,048	9,800	9,800	9,700	9,517
Length. feet	394	394	394	400	440	423	453
Beam, feet	65½	65½	65½	68½	66	65½	64
Draught (mean), feet	25	23½	23½	24½	24½	23½	24½
Primary guns	Four 9·4in.	Two 9·4in.	Four 8·2in.	Four 8in.	Two 7·5in.	—	Two 7·6in.
Secondary guns	Twelve 6in.	Ten 6in.	Ten 6in.	Fourteen 6in.	Ten 6in.	Fourteen 6in.	Eight 6·4in.
Tertiary guns	Ten 3·4in.	Ten 3·4in.	Twelve 3·4in.	Twelve 3in.	Ten 3in.	Eighteen 3in.	Four 4in.
Small guns	Ten 1-pdrs., four Maxims.	Ten 1-pdrs., four Maxims.	Ten 1-pdrs., four Maxims.	Twelve small.	Three 3-pdrs., eight Maxims	Twelve 1-pdrs., 10 automatic.	Sixteen 3-pdrs, six 1-pdrs.
Submerged torpedo tubes	Five.	Three.	Three.	Four.	Two.	—	Two.
Above-water torpedo tubes	One.	One.	One (armoured).	—	—	—	—
Armour	Krupp.	Krupp.	Krupp.	Krupp.	Krupp.	Krupp.	Harvey nickel.
Belt amidships	8in.	4in.	4in.	7in.	4in.	4in.	6in.
Belt at ends	—	—	3½in.	3½in.	2in.	—	4in.
Deck	2in.	2in.	2in.	2½in.	2in.	3in.	2in.
Lower deck side	—	4in.	4in.	5in.	4in.—2in.	4in.	4in.—2in.
Length of this belt	—	150ft.	215ft.	200ft.	350ft.	115ft.	440ft.
Bulkheads, lower deck	None.	4in.	4in.	5in.	5in. (aft).	4in.	6in. (aft).
On main guns	8in.	6in.	6in.	6in.	5in.	—	6in.
Protection to main gun bases	8in. shallow barbettes, then an armoured hoist only.	6in. tubes conical.	6in. tubes conical.	6in. complete barbettes.	8in. shallow barbette and hoist only.	—	4in. big tube.
Secondary guns	Six in turrets, two in casemates, four in battery. On all 6in. armour. Unprotected bases.	Four in turrets, six in battery. On all 4in. armour.	Four in turrets. six in battery. On all 4in. armour.	Ten in 6in. casemates, four unprotected.	All ten in 4in. casemates.	Four in 4in. casemates, eight in 4in. battery, two unprotected.	6·4in. in 4in. casemates, with unprotected bases. Four 4in. unprotected.
Screws	Three.	Three.	Three.	Two.	Two.	Two.	Three.
I.H.P.	13,500	15,000	17,000	14 500	22,000	21,000	19,600
Speed, knots	18·7	20	21	20·75	23	21·5	21
Coal (normal) tons	1,000	1,500	1,500	550	(?)	650	1,000
Coal (maximum), tons	1,100	1,700	1,700	1,800	(?)	1,500	1,600
Boilers	Eight Thornycroft, eight cylindrical.	Fourteen Dürr.	Fourteen Dürr.	Belleville.	Various.	Babcock and Wilcox.	Normand.
Complement	5.9	501	550	(?)	(?)	(?)	612

Paper comparisons are notoriously incomplete. The St. Louis is here so much the worst of the batch, that we suspect her to be far and away the best of the lot in nautical qualities. It is so characteristically non-American that we are forced to believe this. She will probably turn out able to beat all the others at steaming on long courses. However, so far as paper goes, the new German design holds its own very well with all the others. Her dimensions, it will be noted, are very akin to the Elswick Iwate class. These, it is said, roll a great deal, the German design being weighted with as much, or even more, upper works, may therefore roll more or as much. In lines the two are very alike. Still, there is a strong belief that our County class will roll tremendously, that the Montcalm class will, goes without saying: so the German ship is not likely to be peculiar. Possibly some of the St. Louis' hidden virtues reside here.

In the matter of handiness the Elswick cruisers are very good, we may take it that the Germans will be equally so—certainly better than the British, French, and American designs. This the dimensions indicate.

A word may be said here about the class of 4in. armoured cruisers now springing up. We have some eighteen building or projected. America has four in hand, Germany three—that is, twenty-five ships all told, covered with a good deal of thin armour. It is the type of the moment. It corresponds in a measure with the Latona class of a decade or so ago. That class has little use now, and we are inclined to think that the new type will be no longer lived. Four-inch armour is very thin. It will not keep out 8in. or 7·5in. projectiles now; in the future the 6in. gun is likely to be able to defeat it. It will be worth the gun's while to do so, and that almost entails the invention of the necessary projectile. Apart from this, have high-explosives been fully considered? On the proving ground they will shatter 4in. plates all to pieces, even from 6in. guns. Cruisers will have to face 8in. and 9·2in. shell frequently enough, and the efficacy of 4in. armour against these is very doubtful. In view of this, the Asama seems a safer type, hence the 4in. armoured cruiser seems likely to be a transient type.

However, the type exists, and of the three, in the matter of handiness, armament, and disposition of armour, the German design seems superior to the County class or the American St. Louis. The Germans' big gun bases are shell-proof, while the County Class have a mere tray, easily incommoded by shell. Attention may be directed to the form of the Germans' barbette bases. They embody the shape that has long been held ideal—too ideal to construct. The question is, how will they be constructed? for as yet they only exist in design. Anyone familiar with armour construction is aware that the Krupp process lends itself badly to anything save vertical plates, so much so, indeed, that in all our ships turrets are constructed of nickel steel in preference to the superior armour. The theory—if it be not a deal more than a theory—obtains that when very hard armour is used for curved plates, work on them takes away all their virtue. The inverted cone of the German turret bases offers a far more difficult piece of work than any turret. It is not known whether Herr Krupp, who supplies the bulk of German armour, has solved the problem and is making these bases of Kruppised cemented steel, or whether nickel is resorted to. The point is important, but in any case the defence is altogether superior to that in our County class. The German 4in. battery is probably not so good as the casemate system in our County class. One 6in. high-explosive between the second and third funnels would beyond question put the four upper deck turrets out of action, and its effects might reach to the battery below. A single medium projectile in the main deck battery would probably wipe out all the six 6in. in the German ship. Both are in the category of possible hits. The County class, on the other hand, need at least six hits by medium projectiles—putting aside particularly "lucky shots"—to disable the ten casemates. Both cases are instances of compromise, of course, due as ever to the fact that a warship has to move fast, and to ensure that moving leaves none too much weight for guns and armour.

In comparing the Prinz Heinrich with her later developments, we may draw attention to the following—all improvements:—

(1) Four 8·2in. substituted for two 9·4in.

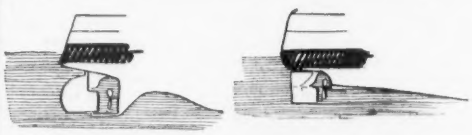
(2) Great increase in the length of the lower deck side belt, thus encasing the bases of the ammunition tubes of the big guns.

(3) Cellulose belt placed as indicated in the dotted portion of the plan.

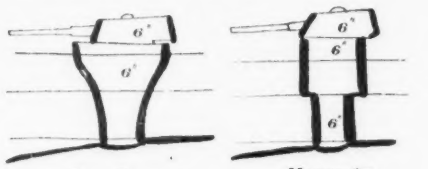
(4) Slight reduction of superstructure, &c.

Having unfavourably criticised the concentration of the 6in. guns, we feel that, in conclusion, some reference should be made to the advantages that presumably led to its adoption, even with the thin armour that is its chief fault. Control of fire in the battery should be extremely easy. In our County class it is going to be anything but easy. If—as may very possibly happen—fire control in battle becomes a matter of sending messengers, the German idea offers great advantages. All the 6in. guns can be got at nearly at once. In the County class they certainly cannot be. Hence it comes that, given thicker armour, the German design should not be far off the ideal cruiser, for her weak point would then only be the four little turrets nested together amidships. In action, the life of these is likely to be very short, and the armouring of them probably a waste of weight. The first shell is practically certain to jam them.

Finally, the cellulose over the bow is an indication that the Germans have been studying things nautical a good deal more than they did a few years ago, when their vessels certainly suggested the soldier's idea of a warship. That particular form of originality is now abandoned. When next German design essays originality, the result, we may safely prophesy, will be nautically far more satisfactory.

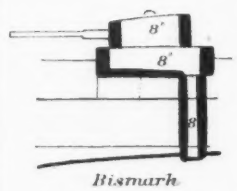


Fürst Bismark *Prinz Heinrich*

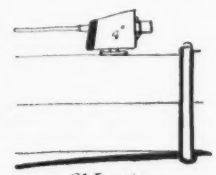


New German, and now adopted for P Heinrich also

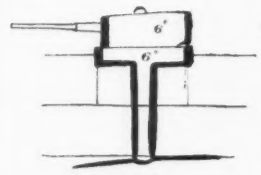
Montcalm



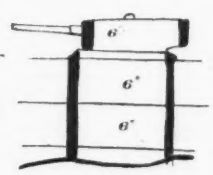
Bismarck



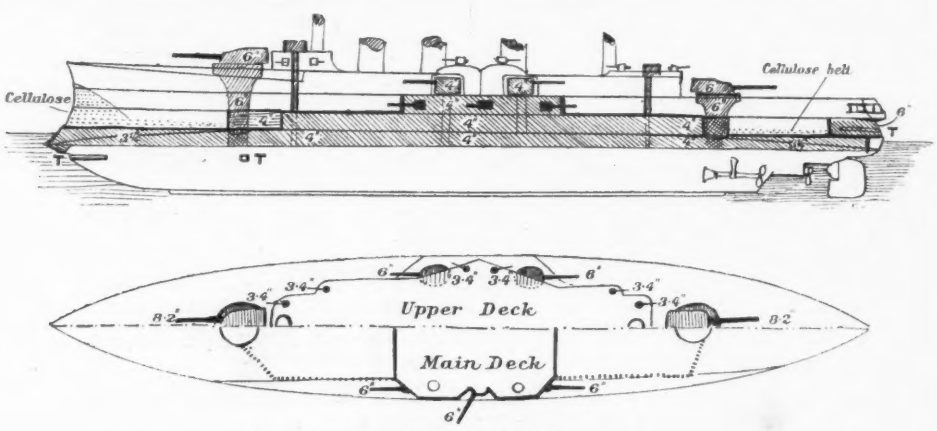
St Louis



County" class



Iwate



SECTION AND DECK PLANS

MANCHESTER ENGINEERS' ASSOCIATION.

ALTERATION OF RULES.

AT the annual general meeting of the Manchester Association of Engineers, held on Saturday, Mr. Henry Webb, who presided, submitted a proposal that the rules of the society be altered in accordance with a notice of motion that had been given. A draft of the suggested new rules had already been circulated amongst the members. The rules at present governing the Association had, he remarked, been in existence, with only a few minor alterations, for forty-six years, and even the most conservative must feel that with changing times some alteration in the rules was necessary. One important change that was proposed related to the method of electing members, which the Council suggested should be simplified, and brought more into line with the system adopted by such societies as the Institution of Mechanical Engineers and the Iron and Steel Institute. Another, and the most important change, was to do away with the distinction between honorary and ordinary members, so that in future they should all be simply "members." In removing that distinction it was proposed to discontinue the system of funeral and superannuation allowance, disablement grants, &c., so that the society should be purely a scientific society for the dissemination of valuable and useful information amongst the members and in the engineering world generally. The proposed new rules, however, contained clauses which adequately guarded the right to benefits of existing members.

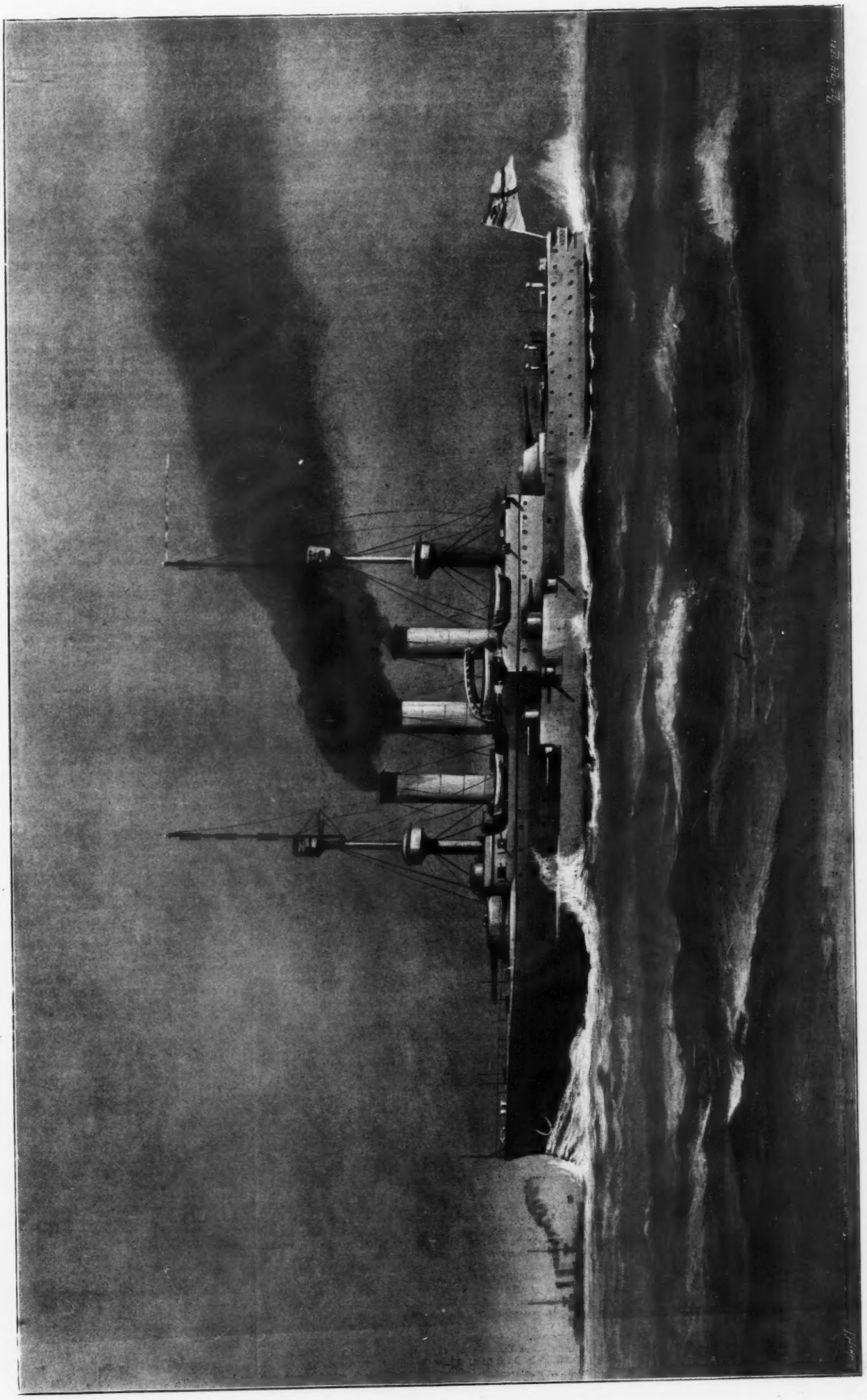
Mr. T. Ashbury seconded the proposition, and a long discussion took place, but ultimately, on the motion of Mr. Joseph Nasmith, seconded by Mr. James Saxon, it was resolved that, whilst approving generally of the principles of the proposed new rules, the meeting should stand adjourned until some date to be fixed by the Council, and in the meantime suggestions for amendment of the rules as drafted should be forwarded to the secretary for consideration by the Council, and reported on at the adjourned meeting.

Officers for the ensuing year were elected as follows:—Mr. James Walthew, treasurer; Sir W. H. Bailey, Messrs. T. Ashbury, J. West, S. Dixon, and H. Webb, trustees; Messrs. G. Daniels, G. Saxon, and H. N. Bickeston, members of Council in place of those retiring; Messrs. Thomas Roberts and W. Ingham, auditors; Mr. Frank Hazelton, secretary; and Mr. Robert Gass, librarian.

The chairman, having expressed the high appreciation of the members of the services rendered by the retiring president, Mr. Henry Hodgson, and their great regret that a breakdown in his health had necessitated a temporary change of climate, which they hoped would bring about complete restoration, proposed the election of Mr. E. G. Constantine as president for the ensuing year. This was seconded by Mr. Alfred Saxon, and unanimously agreed to, a vote of thanks being also accorded to the retiring president. The proceedings included the election of twenty-five new members.

GERMAN ARMOURED CRUISER KÖNIG WILHELM ERSATZ

(For description see page 650)



AN EARLY LONDON RAILWAY.

AT that early period in the development of the railway system when it was intended that the Great Western should join the London and Birmingham near the present Willesden Junction and run over it to a common terminus at Euston-square, it was suggested that a branch from the meeting place to the Kensington Canal would prove a useful feeder to both lines. The canal, opened in September, 1828, ran up from the Thames at Counter's Creek, Chelsea, to a basin now occupied by the Warwick-road coal depôt, Kensington. It had been a total failure, but, of course, a railway connection might help it. A society was formed, with the ponderous title of Birmingham, Bristol, and Thames Junction Railway Company, obtained an Act of Parliament on June 21st, 1836. Its capital was to be £150,000, with power to borrow £50,000 more. Purchase of the canal for £36,000 was one of the conditions laid down, and the works would have been mostly of a simple and inexpensive nature.

Very soon, however, the Great Western resolved to adopt the 7ft. gauge, give up the proposed junction, and seek an independent terminus "near the basin of the Paddington Canal," at Paddington. This was authorised on July 3rd, 1837, and involved crossing the line of the Thames Junction Company on the level. To get under the Paddington Canal, which runs between the two great railways, parallel to both, and with its water-level about 20ft. above their rails, the junction line constructed a brickwork gallery 110ft. long, opening at its south end directly upon the Great Western. This still remains, though closed up at the other end and disused, 2½ miles from Paddington. The covered way was made wide enough for two narrow-gauge lines of rail, with a footway at one side separate from them. The archway is rather a striking object, with a Grecian pediment of stock brick above an elliptical opening turned in light red fine-jointed brickwork. An ingenious bridge, long replaced by a girder structure, of four cast iron arches, with the roadway and two footpaths suspended between them, formerly carried Scrubbs-lane at this point over the canal, where the latter is above the tunnel. This combination of road, canal, and railway, one over the other, was thought a wonderful thing in its time. The arch at each end of the subway is some 20ft. high, but the canal lies in a cast iron trough, under which there is only 14ft. 3in. headway. Drawings and a description of this work may be found in F. W. Simm's "Public Works of Great Britain," 1838, and the *Illustrated London News* of December 28th, 1844, has a curious view of the level crossing at night. The headway is enough, of course, for locomotives, but they were not intended to be used. There is an invert below the archway. The works here were executed in 1838 and 1839, Messrs. Cubitt being the contractors, from the designs of Mr. Wm. Hosking, F.S.A., engineer of the Thames Junction line. About 3 furlongs north of this point the railway joined the London and Birmingham, 5¼ miles from Euston. A small station called West London Junction was erected, part of which still remains, adjoining the Willesden No. 1 signal-box. The original Willesden Station, by the way, was practically a level-crossing house on the road to Acton, at the six-mile post. For many years only about four trains each way stopped there.

The Thames Junction Company soon grew ambitious. By October, 1836, it had resolved upon extending the line from the terminus behind Kensington-crescent, along the south side of the Hammersmith-road and through the waste lands now occupied by South Kensington Museums, to a West End terminus at Montpelier-square, Brompton. Being in a philanthropic mood, the directors congratulated themselves that by having to deepen and straighten a number of sewers, they would be adding to the healthiness of the district. This benevolent scheme failed to pass Parliament, a resuscitation of it in 1844 being equally unfortunate.

Perhaps the most interesting event in the history of this small line is its connection with the first practical trials of the atmospheric system. Mr. Henry Pinkus, its inventor, had in 1837 formed a National Pneumatic Railway Association, which arranged with the Thames Junction Company for a trial upon half a mile of its line when the works were sufficiently advanced. If the result was good, the company were to work the whole line on this system, free of charge. Experiments on a short line alongside the Kensington Canal in 1837 ended in failure, but in 1840 Clegg and Samuda's improved method was laid for half a mile, somewhere between Uxbridge-road and the Great Western Railway.

From Samuda Brothers' report, dated June 18th, 1840, it seems the experiments began on June 11th, and were continued on Mondays and Thursdays from 3 till 5 for a little while, and later on at irregular intervals. The air-pump was 37½in. in diameter, with 22½in. stroke, worked by a 16 horse-power condensing engine. Only a single line, with posts to mark every two chains, was provided, the gradient rising northwards 1 in 120 and 1 in 115. A table of the speeds and loads on June 11th and 15th, 1840, compiled by Mr. Hensman, of Waltham Abbey Powder Mills, shows that the maximum load taken was 11½ tons at 22½ miles per hour, whilst 30 miles was got with 5 tons 9 cwt. The tube was only 9in. in diameter, the pipes not being bored inside, but lined with a coat of pressed tallow, $\frac{1}{16}$in. thick, to diminish the friction of the piston. On Monday, June 29th, 1840, the late Prince Albert witnessed the trials, and was greatly interested. A vacuum of 18in. of mercury was obtained with 1½ to 2 minutes' pumping, the gauges at each end practically corresponding. Forty to 42 strokes per minute were usually made by the pump, but owing to insufficient boiler power this fell off towards the end of the run. There was no doubt higher speed could have been got on a longer and larger tube, as was proved elsewhere later on; but the ridiculous loads excited derision even then. The line was laid in a "rough and irregular manner" with some of the original rails from the Liverpool and Manchester Railway. About 1843 the plant was removed by Samuda's people, "who were rather unwilling to quit the line."

At the period of the first experiments the West London Railway, as it became by an Act of July 23rd, 1840, was regarded as an abandoned project. Funds came in so very slowly that the works again stopped for a considerable time. The scarcity of money owing to the large number of "calls" on railway shares was so great that many small holders could not pay up. Between Uxbridge-road and the Canal basin the Counter's Creek sewer had to be altered and re-laid at great expense, as, the atmospheric principle being abandoned, more headway had to be given under the bridges.

About 1840 the engineer, Mr. Hosking, resigned and was succeeded by Robert Stephenson, but railway property was then depreciated and even his name could not attract investors. He favoured the Knightsbridge terminus scheme, condemning the canal as useless, as it could only be entered or left near high tide. Instead of it, he suggested an extension of the railway to the Thames, a little above Battersea Bridge, where, by quays or wharves, both goods and passenger traffic could be carried on at all times. The most extraordinary ideas had been entertained of the value of the canal. "Boat carriages" on trucks were to run from the large railways and to descend into the canal basin at Kensington, whence steamers would take them down to London Bridge. It was thought barges with goods could be towed down to Blackwall on the tide in four hours. Even at this early date, however, shrewd men saw that the true function of the railway was to cross the river and join the southern lines. One of these schemes was to go to Wandsworth, buy up the Surrey Iron Railway, rebuild it as a steam line, and join the Brighton at Croydon, but it was never even attempted.

At last, on Whit-Monday, May 27th, 1844, the West London Railway was opened for traffic as a single line to the junction with the Great Western. Trains are said to have run every half hour from 9 a.m. On June 10th a time bill was issued, from which it appears that four trips daily were made from Kensington to join the Birmingham Company's trains, and three to meet those of the Great Western. Only two return trips, however, are shown from each line. The Great Western put up a temporary station, called Wormwood Scrubbs, near the level crossing, and there was a station named Shepherd's Bush, at Uxbridge-road. The working proved utterly disastrous, six months' expenses being £586 and receipts £74 15s. 3d. In the same period the canal earned £205 at a cost of £33, but over £1000 had to be spent in dredging and repairs. The company was now £60,000 in debt. Four judgments had been registered against it, and its acceptances were dishonoured. On December 14th, 1844, a creditor advertised that the whole of the movable plant would be sold three days later. It comprised "a capital locomotive engine and tender," the rails, both fixed and loose, the very cranes at the wharf, and the fittings of the four stations down to the waiting-room tables. Purchasers duly assembled at Kensington Station, but no sale took place, a temporary arrangement having been made with the London and Birmingham. Passenger traffic ceased on November 30th, 1844, and was not resumed for nearly twenty years. It was announced that the "Goods Train" would be continued as usual, but we have been unable to follow its small journeyings in any time-table.

To account for this extraordinary result of the working of a London suburban line, it must be remembered that hardly any population then existed near its course. It lay between Kensington and Hammersmith, but too far from either to be of any use. Ponds, gardens, and even wheat fields abounded, but the only traffic lay towards London. The canal had been just as great a failure. The two large railways had no desire to have their termini supplanted by one at Knightsbridge, and the level crossing was a sore subject with the Great Western Company.

Simultaneously with the closing of the West London, the Birmingham and Great Western companies ceased stopping any trains at their junctions with it. The former arranged to lease the short line for 999 years. By this agreement, the West London's debt of £60,000 was to be paid, and the line taken over at a rental of £1800 a year. This was soon altered, the Great Western taking half these responsibilities upon itself in 1845, and the West London becoming practically the joint property of both lines. The new owners temporarily put some life into the concern, obtaining in 1846 power to extend it to the Thames at Fulham Town Meadows, and in the following year to carry it to Hammersmith, Acton, and to the Waterloo extension of the London and South-Western Railway, then being made, at Vauxhall. The times were bad, however, after the railway mania, and none of these projects were carried out. In 1854 the lease to the Birmingham, then London and North-Western, was given up, and fresh arrangements made between that company and the West London, but without prejudice to the Great Western's rights agreed to on March 11th, 1845.

Another interval of unprofitable somnolency followed, till at last the absolute necessity of linking together the railways north and south of the Thames forced itself upon the great companies. The policy of holding aloof from each other had become impossible any longer. An Act was passed on August 13th, 1859, incorporating the London and North-Western and Great Western Railways, under the title of the West London Extension Railway, for the purpose of connecting the old West London with the Chatham and Dover, Brighton, and South-Western lines at Battersea and Clapham Junction. The West London had introduced a Bill for this purpose, but the shareholders responded so badly that it was compelled to call upon the great lines concerned to take up the scheme jointly. This they did, the London and North-Western and Great Western subscribing each one-third of the necessary capital, the Brighton and the South-Western finding the other one-third between them. Certain dividends were guaranteed to the various classes of West London shareholders in perpetuity. This difficult deal was negotiated by Mr. W. Cubitt, M.P., and after raising more money in 1861 and 1863 in the same proportions, the West London Extension was opened across the river on March 2nd in the latter year. To make it, the Kensington Canal and basin were filled up as far as King's-road, Chelsea, and the line made on their site, the end of the canal, now only 32 chains long and known as Chelsea Dock, being diverted eastwards. The extensions were made mixed gauge, except the curve into Clapham Junction, the Great Western paying the extra cost. The broad-gauge rail, however, was virtually never used and was taken up in 1876. It ran into Victoria at that time.

By 1862, the level crossing of the Great Western Railway being superseded by an over-bridge, the London and North-Western took advantage of the Great Exhibition at South Kensington to re-open the West London for passenger traffic. On June 2nd a service of four trains each way between Kensington and Harrow was put on. Euston tickets were made available at Kensington, the Exhibition, 1¼ miles off, being reached by omnibus. The opening of the extension naturally led to an increase of traffic northwards, the Harrow trains being increased to six, and a service to Chalk Farm from five trains each way to nine. In April, 1863, the Great Western commenced a service of eight trains each way between Southall and Victoria, coming on to the West London at the North Pole Junction, where the new overhead line to the London and North-Western Railway parted from the original system on Wormwood Scrubbs. A station was opened a little south of this junction in 1871 by the North-Western, and is only used by its trains. For years called Wormwood Scrubbs only, it now bears the "genteel" appellation of St. Quintin Park as well. There was no station at Uxbridge-road when the re-opening took place, although one was soon added.

The West London Railway now extends from the North Pole Junction to Lillie Bridge Goods Junction, near West Brompton, a distance of 2¾ miles, of which the last half mile is used by goods trains only. The West London Extension runs alongside this half mile, beginning at Earl's Court Junction signal-box. The station named Addison-road is a quarter of a mile north of this, and is used by the South-Western and Brighton companies under lease from the West London, or rather from the Joint Committee of the North-Western and Great Western which does duty as such. As a matter of fact, the West London Company only exists as a name for its old shares, upon which the Extension Company pays perpetual annuities. By an Act of July 28th, 1863, after handing over the shareholders' register, corrected up to date, and all its properties and rights, and any cash in hand, to the Extension Company, the West London was to be dissolved and cease to exist. These operations, however, took a considerable time to effect, the register being in a complicated state. There were several classes of shares, mostly issued at heavy discounts, some partly paid up or forfeited, so that it was about the end of 1865 before the troubled existence of the little line came nominally to an end.

Five directors from each line form the Joint Committee; four from each and two a-piece from the Southern partners constitute the Extension Company. The lines are really worked as one by a staff controlled by the joint superintendent, Mr. H. H. Jebb, at Kensington—Addison-road—Station. Each company has its own booking-offices at the latter, so that there are four ticket windows on each side. At Uxbridge-road the two companies preserve the same system. Nevertheless, all local tickets between Addison-road and St. Quintin Park are issued by the London and North-Western, which is still the predominant partner. The Addison-road station-yard and site is one of the finest and most spacious in London, and has still room for large extension. Both main platforms are of extraordinary length, with four lines of rail between them and large dock or bay accommodation at the ends.

The running companies provide their own engines and rolling stock. The Extension Company has none, nor the Joint Committee, conveniently known as the West London. Probably the engine advertised for sale sixty years ago was the only one the old company ever had.

Through additional connections and the marvellous growth both of its neighbouring population and of railway traffic generally, the West London has come to be one of the busiest lines in the world. Here and there traces of its former self may be observed, the small sheds and buildings on the west side of Warwick-road being strongly reminiscent of the old canal basin they originally bordered. As a link in the railway chain from the North to the South of England the value of the line is immensely disproportioned to its very small dimensions.

DOCKYARD NOTES.

THE appointment of Mr. Watts to the post of Chief Constructor has, as might have been expected, led to a good deal of comparison between Elswick and Admiralty designs. Cold facts make the Admiralty craft look bad enough in paper comparisons, so that the inaccuracy indulged in by so many of these comparisons is very unnecessary. In nearly all the Admiralty designs normal coal is compared with the bunker capacity of the Elswick style. It is the spreading abroad of false statistics like these which hardens the hearts of those who compel our constructors to load British vessels with hundreds of tons of useless fads. The false statistics are easily proved false, and then there comes a reflex wave which says that, after all, the Admiralty designs must be the best possible, and the naval officers' desire for more guns mere moonshine.

THE three new Swedish battleships "A," "B," and "C," now completing, have been named Aran, Vasa, and Tapperheten. A fourth vessel of the class is being built. We are wont to regard the Swedish navy as a small affair; but it is worth noting that it is superior to the Russian fleet in the Baltic, and has been for some time. Some realisation of this may account for the recent Russian utterance that war between Russia and Japan was not desirable just now.

THE Centurion is to be reconstructed at Portsmouth, and her present pop-guns, 4·7in., are to be taken out of her; 6in. quick-firers—whether the Mark VII. Vicker's, or the older 40-calibre piece, is not known as yet—will replace them. The ships should, of course, never have carried anything else but 6in., ten 4·7's being a ridiculous secondary battery for a 10,500-ton ship. It has been rumoured that instead of the six upper deck guns practically unprotected, four 6in. guns only, well protected, will be placed. This would certainly be preferable to the present arrangements.

THE Hogue's trial results are:—30 hours, four-fifths power, indicated horse-power 16,456 = 20·15 knots; 8 hours, full power, indicated horse-power 22,065 = 22·1 knots. The 30 hours' trial is all the more satisfactory, because it was run in very bad weather. It means that the Hogue may be written down as able to do her 20 knots without regard to weather, so long as her coal lasts, bar accidents. These long four-fifth power trials are the real test of our warships, and of far more value in determining practical data than the shorter full-power trials. The coal consumption was rather high, being 2·05 lb. at the four-fifth power trial; 1·5 lb. represents the ideal, which the Vengeance reached. However, it is doubtful whether these consumption figures one way or the other really indicate very much. When ships are in commission the actual consumption depends upon a variety of causes—second-class stokers amongst others. The number of these in a ship affects the consumption hugely. Still, it may be argued that full speed also depends as much as anything on the ease or otherwise with which coal can be got from the bunkers, and so on all through.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Staff engineers: R. W. Jones, to the Duke of Wellington, for the Marathon; and M. Blakeman, to the Vivid, for the Comus. Engineers: C. V. Hardcastle, to the Magdala, for the Plassy; C. Broadbent, to the Assaye; H. W. Harris, to the Duke of Wellington, for service with gunboats at Haslar; W. F. Mitchell, to the Duke of Wellington, for the Fawn; and F. W. Sydenham, to the Pembroke, for the Lee. Assistant-engineer: J. R. Drake, to the Espiegle. Assistant-engineer (temporary): J. A. Anderson has been promoted to the rank of engineer on the permanent list, and re-appointed to the Magnificent, on promotion.

RAILWAY MATTERS.

ON the Midi Railway of France manganese bronze stay bolts are being employed for the fire-boxes on the new fast engines.

THE laying of the rails of the Uganda Railway has been completed to the Victoria Nyanza, the rail head reaching the shore of the lake on December 19th.

AN order has been promulgated in Portugal approving the survey of the railway line from Santa Comba Dão to Viseu. It has been presented by the Companhia Nacional de Caminhos de Ferro, and the length is 49·5 kilometres.

THE proposal for the construction of a new railway line to serve the new coalfields in Midlothian, which are shortly expected to be opened, has been abandoned. The application for a provisional order, under the Private Bill Procedure—Scotland—Act, has been withdrawn.

ON the majority of the main lines of the Eastern Railway of France—Paris-Nancy, Paris-Charleville, Paris-Belfort, Laon-Delle—the service is maintained by trains having to perform more or less lengthy runs at average full speeds attaining 56 miles an hour in order to keep to schedule time.

IT is reported that the Cincinnati, Hamilton, and Dayton Railroad have been experimenting with coke, and so far it is claimed to have been successful. The experience of other roads has not been at all favourable, and even the Boston and Main road has not been able to make it entirely satisfactory.

ACCORDING to the *Gazette de la Bourse*, the Russian Minister of Ways of Communication has under consideration the question of constructing a railway between St. Petersburg and the Imatra Fall. The line would pass between Lake Ladoga and the Gulf of Finland, running almost parallel to the Finland Railway.

THE Pennsylvania and Long Island Railroads are about to construct a tunnel through New York city and under the East and Hudson rivers, which form the eastern and western boundaries of Manhattan Island. It is stated that the tunnel, when completed, will be the longest in the world. Its length will be over 15 miles.

THE Pennsylvania Railroad Company is about to construct a new tunnel to be built through the Allegheny Mountains at Gallitzin. This is to be 3600ft. long, parallel with the existing tunnel, of the same length, and 80ft. south of it. This new single-track tunnel is designed for west-bound trains, thus relieving the existing tunnel.

AN official of the Chicago, Milwaukee, and St. Paul Railroad is responsible for the statement that the damage to draught rigging on this line has increased fourfold in six years. Some men think that rough switching in yards is responsible for most of this damage, but the greater part of it is possibly due to the unavoidable shocks which the cars receive on the road.

ON the lines of the Austrian State, some express trains, scheduled at an average running speed of less than fifty-six miles an hour, attain in practice speeds varying between fifty-six and fifty-nine miles an hour on gradients of from 1 in 200 to 1 in 100, while hauling trains of 160 metric tons, and consisting as a rule of four cars with four axles each and two vehicles with three axles each.

ON the boilers of the Kaiser Ferdinands-Nordbahn and the Hungarian State Railways both the inside and outside cover-strips are of the same width, and riveted together with two rows of rivets on each side of the joint. Everywhere else the outside cover-strips are narrower than those inside, and consequently only the two rows of rivets next to the joint are in double shear, and the outside rows only in single shear.

THE Hungarian State Railways have tried stay bolts of manganese bronze, which alloy, when tested for tensile strength, has given very high percentages of elongation, and at the same time excellent results as regards ultimate stress. The alloy, as specified by the Hungarian State Railways, consists of a mixture of copper and manganese, the minimum quantity of the latter metal allowed by the specification being 3·8 per cent.

IT is proposed to use a mixed system of trolleys and accumulators on the Florentine electric tramways, which are at present being worked on the overhead system. By the new method it is hoped to get rid of the whole of the overhead equipment in the busy streets of the city of Florence, and to run the cars by accumulators until the outskirts of the city be reached, when current would be obtained from the overhead conductors.

THE express trains of the Netherlands State Railways, although they are scheduled to run at speeds between 43·5 and 53·4 miles an hour, attain in reality daily speeds of 56 miles. Such is the case, for example, with the express trains travelling between Flushing and Bokstel, which run in connection with the steam packets of the Queenborough-Flushing line at one end and the German railways at the other, and thus establish direct communication between England and Germany.

THE *Gaceta de Madrid* of the 6th inst. contains a notice to the effect that an application having been made on the part of the Société Anonyme des Tramways Electriques de Teneriffe—Iles Canaries—et Extensions, for the concession of an electric tramway from San Cristóbal de la Laguna to the village of Tacoronte, being a prolongation of the line from Santa Cruz to Teneriffe—Canary Islands—to San Cristóbal de la Laguna. A month is allowed for the presentation of other applications for the concession, accompanied by their corresponding plans and guarantees.

APPLICATION is being made to the Legislature of British Columbia for an Act to incorporate a company to construct a railway from a point at or near Hazleton, on the Skeena River, in the district of Cassiar, B.C., to a point on the boundary line of the province at or near Teslin Lake or Atlin Lake, or both; also from Hazleton to a point at or near the eastern boundary of the province by way of the Skeena, Babine, Driftwood, Omineca, and Finlay Rivers to the Peace River Pass and thence eastward. This projected route involves a line north 350 miles through hitherto unexplored territory for part of the distance, and a line east for 150 miles.

THE Adriatic Railway Company, which has its headquarters at Florence, possesses two important workshops in that city, and one in the neighbouring town of Pontassieve. The most noteworthy is devoted to the general repairing of the rolling stock and the construction of reserve parts. A foundry is annexed to the works, fitted up with three reverberatory and two crucible furnaces, two cupolas, three case-hardening and tube-brazing furnaces; one drop, one power, and five steam hammers, eighty-four lathes, and a variety of other tools. Five steam engines of 108 horse-power provide the necessary motive power to all machinery and blowers throughout the works.

THE application of electric traction to the present steam railways forming the suburban system of Melbourne has recently formed the subject of inquiry by a Select Committee of the Legislative Council, specially appointed to deal with the question. The average speed on the suburban steam lines now is 15 miles an hour, but with electric traction this would be increased to 20 miles an hour. In all there are over 100 miles of double lines within the suburban radius, and in the event of electric traction being adopted, it is intended to apply it to the whole system. An estimate of cost shows that the whole of the existing steam lines could be converted to electric traction for about 2½ millions sterling, allowing for a set off of nearly half a-million on account of the selling value of the present engines, cars, &c.

NOTES AND MEMORANDA.

THERE are five iron foundries in the province of Florence, one of which gives employment to 250 hands.

THE statistics of the German Lloyd's show that 142 steamers, with a total capacity of 317,080 tons, and 94 sailing ships, of 30,190 tonnage, are now in course of construction in German shipbuilding yards.

AN electric supply company in California is about to complete its high-tension line to San Francisco. The completion of this line makes available in the city of San Francisco electrical energy developed on the Yuba River and conveyed a distance of 222 miles.

THE city engineer for Toronto, Mr. Rust, says cedar has been found the best adapted of Canadian woods for street paving, but the tamarac and spruce of the maritime provinces are harder than what is found in the West. The wood is treated with creosote before being laid.

THE cultivation of the olive tree is an important industry in Florence, the oil being of the best quality. The extraction of the oil from the olives is carried out extensively in 35 communes, giving work to 1142 hands. The work is carried out on an average during 45 days. There are nearly 400 mills.

DURING the recent War-office motor wagon trials the Milnes wagon, with a load of five tons—three tons on the vehicle and two on the trailer—covered a distance of 30 miles on a fuel consumption of six gallons of petroleum. The Foden steam vehicle with a similar load used 359 lb. of coal and 205 gallons of water.

SPECIAL facilities for railway travel are offered to commercial travellers in Switzerland. Commercial season tickets available on any Swiss railway except the mountain cable railways are available at low rates. For instance, a first-class ticket for 15 days costs only £3, for 30 days £4 10s., for 3 months £11, and for 6 months £17.

THE name "Macadam" is commonly applied to any road surfaced with broken stone, and in this respect is a misnomer. It is the neglect to provide a dry subsoil that is the greatest cause of the unfortunate condition of roads throughout Canada to-day. The roads of to-day are, in effect, only a repetition of the English roads as they existed before the time of Macadam.

IN the province of Florence there are 202 stone quarries in actual work; 4 of these are serpentine, 5 calcareous stone, 2 grind stone, 5 fireproof stone, 3 calcareous tuff, 170 arenaria—a hard, grey stone for olive presses—11 building stone, and 2 majolica earth. Serpentine and arenaria are used for architectural purposes, calcareous stone for street paving, and tuff for common building purposes.

THE controversy in the United States Naval Board of Construction over the question of recommending the installation of ordinary turrets or superposed turrets on the battleships, which Secretary Long will ask Congress to authorise, has been amicably adjusted. A compromise was effected by which the ships will have ordinary turrets, as recommended by the majority of the Board, but certain features of the battery advocated by the minority will be adopted.

A GERMAN medical paper publishes an article by the celebrated Russian surgeon, Professor A. W. Minin, on the use of blue electric light rays as an anæsthetic during surgical operations. Professor Minin cites a number of cases in which he has used violet rays instead of cocaine in surface operations, or in sewing up wounds, and always obtained the best results. The rays not only acted as a perfect anæsthetic, but also exercised a healing influence on the wounds.

THE *ignis fatuus* of heatless light has led a college professor along weird paths, one of which, says an American contemporary, "has terminated at the extraction of faint light rays from a porter-house steak in a very advanced state of decay. The possibilities of this line of research are appalling. With all the porter-house steaks cornered by the local lighting companies, life would become a joyless monotony. Those to whom fish and fowl do not appeal would certainly prefer comfortable darkness after sunset rather than illuminated starvation."

THE known area of natural gas in Pennsylvania was increased during last year by the extension of the Bayard sand pool from near the State line of West Virginia to a point several miles north of Waynesburg, in Greene County, Pa., many miles of gas-producing territory being thus added to the field in this portion of the State. This Bayard sand is found at a depth of 2410ft. below the Pittsburgh coal. Wells in this sand have a rock pressure of over 1000 lb. to the square inch and a volume which ranges from 10,000,000 to 20,000,000 cubic feet in twenty-four hours.

RECENT experiments with acetylene as an illuminant carried out at Genoa lighthouse proved highly successful. The acetylene light at Genoa was plainly visible at the island of Tino, forty miles distant, though the electric light from the lighthouse at Tino was invisible at Genoa. The fog-penetrating power of acetylene could, of course, not be tested, as fogs are rare at Genoa, and are of short duration; nevertheless, the Italian Government are quite satisfied with the recent tests with the apparatus employed, which was manufactured by Mr. Filiberto Ferraccin, at Savona.

THE manufacture of cutlery is carried out in the province of Florence at Scarperia, Mugello, on the slopes of the Apennines, and dates as early as the fourteenth century. From a document in the Royal Archives of Florence, it appears that as far back as 1535 a Cutlers' Union was formed under the presidency of the Vicar of Scarperia, and a statute was drawn up and duly approved by Cosimo de Medici. Since then this industry has never ceased to be a speciality of that district. It gives work to one-quarter of the population, viz., about 500 persons occupying 30 shops.

ACCORDING to a supplementary consular report on British trade with Switzerland in 1900, it appears that although the United Kingdom is by far the best customer which Switzerland possesses for her manufactured goods, which represent 99 per cent. of her exports to the United Kingdom, yet the balance of trade is very much against us; in fact, whereas we spent £6,984,000 on Swiss manufactured goods in 1900, we only received in return £1,843,000 for the goods which we exported to her. Germany exported to Switzerland in the year under consideration no less than £7,850,171 worth of manufactured goods.

ON April 1st last there were 768 electricity supply works in operation in Germany, as compared with 652 works in the preceding year. 318, or 40 per cent. of the works, have furnished returns of the total of their capital expenditures, and an average of these shows that the expenditure has been at the rate of 1628 marks—about £81—per kilowatt of generating plant installed. The total capital expenditure of public electricity supply works, exclusive of tramways, in Germany, is about 540,000,000 marks; 81·3 per cent. of the works generate nothing but continuous current, as compared with 80·4 per cent. last year.

A NEW acetylene gas generator has been invented at Trollhättan, Sweden. The falling of the carbide into the water is automatically regulated by a rubber ball, which, as soon as it is filled with gas, closes the valve between the carbide and the water. When the volume of gas decreases, the ball contracts, and the feed valve again permits the carbide to drop. The gas is stored partly in the ball and partly in the space between the funnel-shaped carbide magazine and the water. If much gas is generated, the water is pressed through valves into the water jacket in the sides of the apparatus, thus furnishing more room for the gas.

MISCELLANEA.

THE French Minister of War is about to adopt metallic boats for bridge equipment purposes.

THE River Tyne Commissioners have adopted a scheme for improving the ferry service, including landing stages and other works, at an estimated cost of £93,831.

TWO ice breakers are to be set to work at Nicolaieff this winter. No dues will be payable for the breaking of the ice, but towage or salvage service by the ice breakers will have to be paid for.

AS soon as the ship canal to Bruges is completed the Great Eastern Railway Company intends to start a service of steamers between Harwich and Bruges, the voyage to take no longer than four hours.

A TRACTION engine boiler exploded on the farm of Mr. Henry Barker, at Winfarthing, Norfolk, last Friday, and the owner, Herbert Loveday, who was acting as driver, was hurled a distance of 30 yards and seriously injured. The wrecked engine fell upon another man, John Lancaster, killing him instantly.

TWELVE summonses issued against the Central London Railway Company, in respect of the issuing of black smoke from their chimneys at their generating station at the works in Wood-lane, Hammersmith, were heard at West London Police-court last Friday. A fine of £5 on each summons was imposed, and eight guineas costs allowed.

A COMPANY is being formed to take up the carriage of merchandise by motor wagon between Manchester, Liverpool, and Blackburn. The capital is £20,000, and the directors include influential commercial men in Liverpool, Wigan, and Blackburn. The proposal is to compete with the railway in the carriage of goods, for which 10s. a ton and upwards is now charged.

THE British commercial agent in Russia reports that it is stated in the *Russkia Viedomosti* of Moscow, that according to rumours circulating in business circles at St. Petersburg, from next year the Customs duties on many articles of first necessity, such as iron, coal, machinery, and implements imported from abroad, will be in part reduced and in part entirely rescinded.

IT is stated that the Admiralty, owing to the pressure in the Government dockyards, have decided to give out the construction of two of three battleships originally intended to be built in the royal dockyards to private builders. Tenders for these will be issued along with those for five first-class cruisers. The battleships will exceed in gun power and size anything afloat.

THE Mechanical Transport Committee of the War-office, which has had the late motor lorry trials in hand, has decided to award the prizes as follows:—The first prize of £250 and the second of £150 are put together and divided between Messrs. Thornycroft and Foden, and the third prize of £100 goes to Straker. The Milnes oil-driven motor was the only one out of the prize list; but the War-office has purchased the machine.

THE Press Association's Woolwich correspondent says that the Government have, after considerable trials, just adopted a new 10-pounder mountain gun, and an order has been issued for the manufacture in the field-gun section of the Royal Arsenal of eighty-four of the new weapons for service in India. The new gun is jointed, and can be taken to pieces and put together again with great rapidity. It is admirably adapted for conveyance on the backs of camels and mules.

A GREAT scheme is suggested in the *Figaro* for the utilisation of the rainfall of the Pyrenees. It is proposed to dam the valleys all along the chain, hold up all the mountain torrents in a series of artificial lakes, regulate the overflow, run it through turbines, and so generate electric power. It is calculated that no less than ten million horse-power—or about double the horse-power employed in all the factories of Europe—from the Pyrenean range, and supply it at about one-sixth of the cost of the power produced by steam.

A GAS explosion in the conductor rail conduit of the Metropolitan Street Railway in New York recently blocked all the surface lines in the lower half of the borough of Manhattan for almost twenty-four hours. A broken gas main had allowed a large quantity of gas to escape into the conduit, and when a spark from the collector shoe of a passing car ignited the gas, the covers of manholes and insulator boxes for the space of more than a block were blown into the air. The burning gas destroyed the insulation of a group of five feed cables, breaking the circuit at the sub-station.

HAMBURG advices confirm last week's report from New York that the Hamburg-American Line and the German Levant Line have agreed to the joint working of a regular steamship service between North America and the Levant. The Hamburg-American Company will have the management of the business in the United States, while the German Levant Line will direct affairs on the European side. The first boat is to sail from New York in January next, and the departures will be once a month up to July, and after that fortnightly. Both passengers and cargo will be carried.

A FIRM called the Società delle Ferriere Italiane in Florence possesses two blast furnace installations in which previous to 1890 rolled iron in bars was produced by the re-smelting of scrap iron. One of these establishments is situated in the commune of San Marcello, and was fitted with a Siemens furnace and a rolling mill, worked by a turbine of 130 horse-power. It has since been transformed into a copper foundry. The other installation, including three furnaces and four hydraulic motors of 90 horse-power, is situated in the commune of Cutigliano, and is at present not being worked.

THE officials at the Royal Naval Engineering College, Keyham, have been informed that the Admiralty intend entering forty-six engineer students in July next. Of this number forty-two will be entered by open competition, two will be nominated colonial candidates, and two nominated service candidates. In the event of the colonial and nominated service candidates failing to qualify at the examination, their places will be filled by candidates from the open competition list. We understand that two studentships in naval construction will be offered to the most successful candidates on the open competition list.

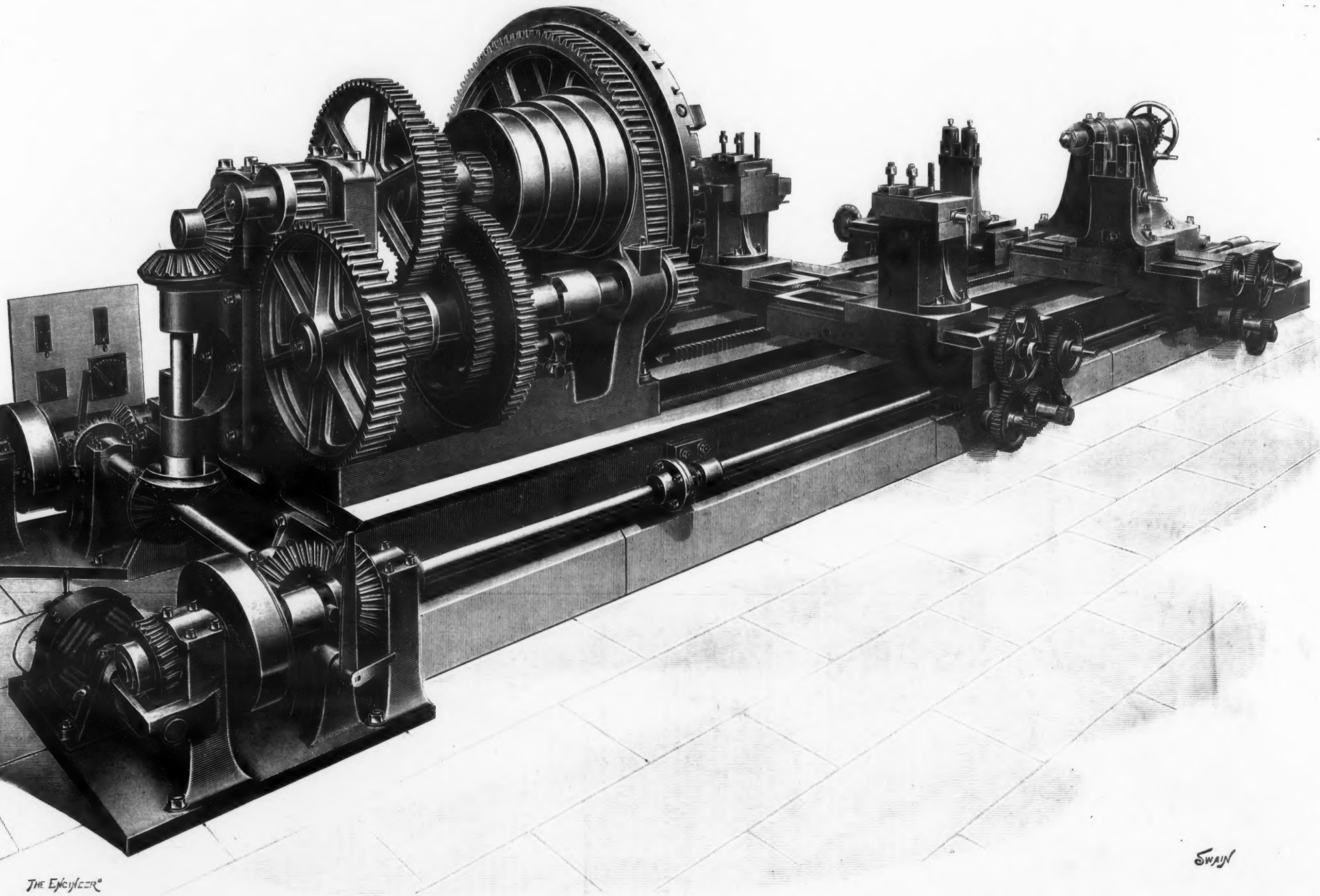
ACCORDING to the Odessa *Novosti*, the Siberian Railway, when commenced ten years ago, was estimated to cost 350,000,000 roubles. This estimate has, however, been exceeded to an extraordinary extent, the difference between the estimated and the actual cost up to twelve months ago being over 430,000,000 roubles. Before the line can possibly be in proper working order there is reason to believe that the total cost of the Siberian Railway at completion will figure out at over 1,000,000,000 roubles, or, roughly, £100,000,000—*i.e.*, nearly three times the amount provided for at the commencement.

A SYNDICATE of capitalists some time ago, under the style of the Barrow-in-Furness Coal Exploration Company, Limited, began boring for coal at Risedale, Barrow-in-Furness. A depth of 2000ft. was pierced, and the red sandstone formation has not yet been got through, and the capital subscribed by the company is exhausted. The cost of the boring has been about £2 per foot. It is not proposed to give the work of exploration up, and we learn that a circular has been sent round to the leading capitalists of the district with the view of raising new capital to get down to a depth of at least 3000ft., to determine what underlies the sandstone formation. In the St. Bees district coal is found beneath these measures, and it is hoped to discover the same conditions in Furness.

HEAVY CRANK SHAFT LATHE

HULSE AND CO., LIMITED MANCHESTER, ENGINEERS

(*For description see page* 647)



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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

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*** *With this week's number is issued, as a Supplement, a Two page Engraving of a Cross Compound Tramway Traction Engine. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. B. T. (Roselló).—The reports about the new storage battery appear to have little or no foundation in fact. Nothing has been heard of it for some months. Small amounts of power have been transmitted over short distances by induction, sufficient to steer a torpedo, but that is all.

MEETINGS NEXT WEEK.

GEOLOGISTS' ASSOCIATION, LONDON.—Friday, January 3rd, at 8 p.m., at University College, Gower-street, W.C. Paper, "On the Waves of Sand and Snow," by Vaughan Cornish, D.Sc., F.G.S., F.C.S., F.R.G.S.

RÖNTGEN SOCIETY.—Thursday, January 2nd, at 8.30 p.m., at 20, Hanover-square. Papers, "On the Function of an Auxiliary Electrode in X-ray Bulbs," by Mr. C. E. S. Phillips; "On Radiography applied to Dental Surgery," by Mr. Prosper H. Marsden, F.C.S.

DEATH.

On the 19th inst., at his residence, 46, Finchley-road, N.W., JAMES CARRINGTON SIMPSON, M. Inst. C.E., aged seventy-three.

THE ENGINEER.

DECEMBER 27, 1901.

TRAIN RESISTANCE.

THE discussion on Mr. Aspinall's excellent paper on "Train Resistance" at the Institution of Civil Engineers terminated on the night of Tuesday week. The paper had been read a fortnight before. It was then partially discussed. On Tuesday, December 10th, the whole evening was devoted to it, and the greater part of the evening of December 17th also. This means that about three hours were expended on its consideration. As it is against the rules of the Institution to publish reports of the proceedings, we can only refer in general terms to what was said. Not the least interesting episode was the little speech made by Mr. Edward Woods, who referred, as though they had taken place the day before, to experiments which he had carried out with the Count de Pambour and Dr. Lardner sixty-seven years ago. Sir F. Bramwell also had something to say about what had happened in the past. Indeed, the impression conveyed by the discussion was that nothing new remained to be said on a subject which had been threshed out by the progenitors of many of the men present. Professor Carus Wilson, for example, showed a model of a couple of bogies on rails, and explained that, in his opinion, something like 60 per cent. of the whole resistance was due to the work done in steering the train; and he went on to argue that the amount of the resistance depended on the weight of the bogie only. Much of this was settled very many years ago. Lardner pointed out the evil influence of wheel flanges striking the rails right and left. Again, it was generally admitted—indeed, by some assumed to be by way of a new discovery—that the heavier the train the less the resistance per ton; but this was ascertained in almost prehistoric times by Lardner and Woods.

The general result of the paper and the discussion is that Mr. Aspinall has added five new formulæ for calculating train resistance to the fifty which already exist. The lesson taught by the history of the numerous investigations which have been carried out is that there is no such thing and can be no such thing as a general formula for train resistance. That resistance varies from day to day, almost from hour to hour, with the weather, the condition of the road, of the wheels, and of the axle-boxes. It is altered with every change in the weight of a train, its bulk, and its length. The very way in which the windows are fitted may so far alter the conditions as to render a given formula inappropriate. Possibly a general recognition of this fact will account for the circumstance that during the three hours' discussion hardly a hint was dropped by way of suggesting some means of reducing the resistance of trains. No one had any scheme to advance. It seemed as though the meeting held that something like finality had been reached; that the modern railway train offered the least opposition to progress that was conceivable, or, at all events, to be realised in practice. The discussion degenerated at last mainly into a somewhat inept criticism of the methods adopted by Mr. Aspinall for measuring the effects of the wind. It was very easy to show that, if his U tubes had been fitted anywhere but where they had been fitted, the results would have been different. The general conclusion was that a wind retards progress, how much no one seems able to say. But this much also was known from the first.

One advantage, at all events, will result, we think, from the meeting. Although we shall be no nearer to knowing precisely what the resistance of any given train may be, we shall at least know what it cannot be. The absurd formulæ which introduce v^3 disappear, we hope, for ever. No matter what the rate at which resistance augments with the velocity, it certainly does not increase as the square of the speed. It is, we think, a pity that none of the speakers directed attention to the very curious and anomalous fact of which we have often spoken, that although the total resistance of a train apparently augments with the velocity, the indicator diagrams grow leaner and leaner the faster the train runs. It is, indeed, quite impossible, because of the action of the valve gear and piston, that it could be otherwise. The driving pressure falls because the steam cannot get quickly enough into the cylinder, and the back pressure rises for just the opposite reason. Yet, if the total resistance of the train increased, the average pressure, on which depends the tractive effort, must also increase; and be it remembered that, although the diagrams become leaner, the horse-power augments because the piston speed rises. The usual method of explaining the fact consists in saying that at high speed the train is always running more or less down hill, an argument which is incomplete and unsatisfactory. The fact must, we fear, continue to remain one of the puzzles which still attend the working of some classes of machinery.

The statement made by Dr. Siemens, to the effect that about 960 indicated horse-power would be required to propel a car weighing 96 tons at 100 miles an hour, is curious and requires some explanation. It is fortunate, perhaps, that he was a little vague, and we are not quite sure whether the speed was 100 miles or 120 miles an hour. At the latter velocity a horse-power would be required to overcome a resistance of a fraction over 3 lb., that is to say, for 960 horse-power a total resistance of about 2880 lb.; but this is equivalent to about 31 lb. per ton for a 96-ton car. We do not see any reason for doubting the accuracy of these figures, but if they are correct it seems that the cost of power for these excessive speeds must be so great that cheap fares will be entirely out of the question. Furthermore, it is stated that the line on which a speed of about 100 miles an hour has actually been attained has been a good deal knocked about, and that it is evident that permanent way exceptionally strong and heavy will be required. If this be so, it appears to us that some other method of propulsion must be adopted which will not render it necessary to have great weight for the sake of adhesion. It may, for example, be found that the old Fell system, with a smooth central rail gripped by two or four, or more, horizontal driving wheels, would be the most satisfactory solution of a very difficult problem. Although that system was very inconvenient as carried out in a steam locomotive, it lends itself admirably to electrical propulsion.

THE RUSSIAN IRON TRADE CRISIS.

THE persistence of the crisis in the Russian iron trade, in spite of the Government's most heroic efforts to bring it to an end, is an object of interest to this country. The latest information is that all the principal ironmakers have agreed to form a trust, with the object of regulating the output, keeping up the prices of iron, and preventing Government contracts from going into the hands of foreign contractors. Even the Ural founders, who have never hitherto been sufficiently united to contemplate combination, have been forced by adversity to energetic action. The new movement is an outcome of the congress which met at Khatkoff recently to consider the situation and devise remedies. At that gathering the thoughts of the patriotic Russian turned first to Government, which had already done so much for him that he had convinced himself it should do more. So a message was despatched to the Minister of Finance almost demanding orders for the Siberian Railway and other public enterprises, if it was not desired to see a wholesale stoppage of work in all the industrial centres of the empire. This appears to have been too much for M. Witte, who had come down very handsomely only a year before when the state of the country's finances might have justified him in refusing aid. Instead of orders, he sent back this message:—"The owners of ironworks and coal mines are continually complaining of the difficulty of selling their products, and of the consequent restriction of the output. However, the imports of these products during the current year up to October 1st amounted to 6,621,000 poods for cast iron and cast steel, to 3,383,000 poods for machines made of these materials, and to 184,122,000 poods for coal. In view of the very high Customs duties imposed for the protection of home industries, I ask the Congress how it is to be explained that people can speak of a difficult situation in the face of such considerable imports of products which might be supplied by Russian industry." It occurred to M. Witte that instead of continually begging for Government work, the ironmasters should proceed along the line hinted in this message—endeavour to meet the home demands for iron and steel goods, instead of allowing the majority of them to be supplied from abroad. All the congress found itself able to do was to suggest the establishment of sales bureaux in the important towns, the bureaux to have the exclusive right to accept orders and distribute them among the individual works according to their capabilities of production. It proposed that the sales bureaux should have power to fix the conditions of sale and the granting of credit, and be entrusted with all matters affecting disputes with clients. The trust, we suppose, is a further development of this idea.

But one fails to see how such a remedy as this meets the needs of Russia's peculiar case. The point is not to regulate prices of castings and rolled steel, but to increase the branches of production so as to comprehend the chief articles of requirement and reduce the country's obligations to Germany, the United Kingdom, and France the well beloved. Surely, if encouragement is given, directly in the shape of a bonus or indirectly in the shape of a phenomenally high tariff, it should be given towards this one end? It is so in the United States, and, whatever the views of the foreigner may be, there is no quarrelling with what has been accomplished there by Protection. As a correspondent of the *Times* pointed out last week, the spectacle of huge steel, iron, and mining concerns in Russia piling up stocks against future orders, measures enforced by the Russian authorities, with the one object of preventing the execution of Russian orders abroad, is disconcerting to metallurgical workers

in a country whose coal and mineral ore supplies are considered to be inexhaustible, and whose labour is the cheapest by far in Europe. Cheap labour is not always efficient labour, but, to do him justice, the fault does not lie with the workman but with his master, who has confined his attention to a few narrow lines, always with an eye upon the Government as the pur chaser. The president of the Metallurgical Society is unable to furnish a reasonable explanation of the position, especially as he claims that the Russian blast furnace, rolling mill, and other plants were never in a better position to supply home demands than they are at the present moment. But he was at no loss with suggestions as to how prosperity might be restored. He asked for the construction of new railways on an extensive scale in Russia by the Government authorities; and the granting of Government assistance to the Russian shipbuilding industry, which is in a lamentably stagnant condition. He asked also that the Russian naval and military departments should cease to fill orders abroad which could readily be executed at home; and he invited the Government to co-operate with his society in its effort to regulate the sale of Russian metallurgical products by the establishment of the agencies or sales bureaux already referred to. It will not escape notice that this gentleman completely evaded the point and asked for more doles. It is quite clear that until they realise the necessity for more self-reliance, and produce the commodities which it is now necessary to bring from abroad, the Russian iron manufacturers will never again find themselves on a satisfactory footing. They are too numerous to be kept in steady work by Government orders; and, as the official organ of the Ministry of Finance points out, there has been a plentiful lack of wisdom in the organisation of many of the establishments founded—most of them with money the loss of which is being loudly lamented by French and Belgian shareholders—in South Russia, especially during recent years. Financial irregularities, over capitalisation, disregard of unpromising local conditions—these are only a few of the causes which have contributed to the present fiasco. The saddening thing for M. Witte is that it should have been produced in spite of his many sacrifices. The high tariff has been a virtual failure, and, notwithstanding its big workshops, the Russian iron industry stands just about where it did ten or more years ago.

In his emergency, M. Witte falls back upon the old remedy—the introduction of English capital, the investment of which in Russia he is endeavouring to induce. "Our Government," he is credited with having said, "has decided to do everything that it can to facilitate English enterprise in the empire, for we are disgusted with the way a horde of cosmopolitan financiers has exploited the concessions we have given them." We have no doubt there is a good opening for British capital in the mining and manufacturing industries of Russia, provided it be employed with discretion, but great care is necessary if additions are not to be made to the already long list of failures.

THE NEW UNITED STATES WARSHIPS.

No warships, perhaps, have had so many vicissitudes as the United States battleships of the New Jersey class. Once again they have been definitely decided on, permanently, perhaps, now; but it need not be forgotten that earlier designs have been "final" also. There is no getting away, however, from the fact that each new finality has been better than preceding designs. As with each the displacement has gone up this is not to be wondered at; but the great and essential point is this increase of displacement. In the past American ideals have tended to "whip creation" with the minimum of displacement; now obviously nautical influences can be seen at work, with the result that we observe an honest striving after a real best in place of what—rightly or wrongly—has hitherto been under suspicion of being rather a paper best. In fine, America is now definitely settling to building American warships to American needs.

The new battleships are to be of 17,604 tons normal displacement, 450ft. long by 76¾ft. beam by 26¾ft. maximum normal draught—the relatively small draught being necessitated by the depth of water about the American coast. Our 16,500-ton King Edward class will be, therefore, small ships beside them. The main belt, 9½ft. deep, will be 11in. thick on the water-line amidships, this thickness soon fading to 9in., and diminishing to 4in. at the extremities. Here, then, we have the maximum of moderation in the disposal of the 4000 to 4500 tons odd of armour. No weights have yet been published, but, very approximately, this belt can be put at about 1500 to 2000 tons odd. A 7in. belt protects the lower deck above—roughly, another thousand tons nearly. This, of course, includes bulkheads. The balance of the armour goes to barbettes, turrets, and battery. The armament will be four 12in. guns in the usual turrets, eight 8in. at the angles of the superstructure—the somewhat amateurish superposed turret idea being discarded, and ten or twelve 7in. guns in the battery, protected by 7in. armour. This 7in. gun is a piece yet to be built. It is to be adopted because it "will pierce 7in. of armour at 3000 yards." At sea, in battle, it is not likely to do anything of the sort, and the carrying of A.P. projectiles for the purpose must lessen the supply of the more useful common and high-explosive shell. However, no constructors have yet grasped the idea that secondary guns are shell guns, and that with high explosives to burst outside near a gun muzzle is likely to be more destructive than to make a hole in the place where the gun is. The great thing is to disable the gun. The burst of a 7in. shell will be far superior to that of a 6in., but the latter is, with H.E., powerful enough for anything against so ideal a target as a ship. The Americans would, we think, have been wiser to have had the same weight in 6in. pieces, unless—as is possible—space for them and their ammunition arrangements constitute the objection.

A remarkable feature of the new ships is the absence of all torpedo armament. This, too, we consider a mistake. After all, the weight of submerged tubes is a bagatelle in 17,604 tons; nor, in so large a ship can the saving of space matter very much. Useless the torpedo may be for long range actions, but it has had much to do with the new leaning to long range work. After many guns are disabled, after speed is reduced, ships are likely to get within torpedo range, while the absence of tubes is a draw to the enemy to do so. To be sure, by then all directors may be smashed; but of this there is no certainty, while the same objection might be extended to sighting hoods for guns and many other things.

We have drawn attention to these defects, not in a carping spirit, but because in spite of them we still hold these 17,604-ton ships, so far as the meagre details available allow, superior to any other battleship designs, not merely as ships, but per ton of displacement. Political events, too, add an interest to American sea power. We are small believers in the Utopian dreams of a great Anglo-Saxon world-empire; but there are many indications that, whether the idea be pleasant to Americans or not, the great war of the future will find their ships fighting side by side with ours.

The new cruisers are, as yet, so shadowy that it is impossible to criticise them to any extent. But nothing could be sounder than the principle laid down by the Board, that while a battleship may have 22 to 28 per cent. of armour, cruisers must be content with from 7 to 20 per cent.—the balance being expended in speed. It is a palpable truth enough; but a review of existing types would hardly go to prove it conclusively. The nations are realising it slowly.

The armament spoken of for these vessels is four 10in. and sixteen 6in.—no great change over existing models, save in the adoption of 10in. in the place of 8in. for the turret guns. The horse-power is 25,000, with 22 knots. For the battleships, speed has been written down as a minor desideratum, and they will be 18 knots only, with 16,500 horse-power.

A very important feature in both types is the abolition of triple screws, after which the engineer-in-chief is supposed to hanker. Executive officers seem to have formed the opposition, and they have carried the day on the grounds that however advantageous the triple system may be in coal economy, it lacks the tactical advantage of the twin-screw system. Purely engineering disadvantages might also be alleged, but the primary question is one of fighting capacity. With two screws there is over 8000 indicated horse-power available for assistance in a sudden turn; with triple screws considerably less power is available. This is the gist of the argument that has carried the day again with the United States Construction Board, and it argues a sound appreciation of a warship as a fighting machine before all else. This is the dominant note all through the report, from the specific reasons against wood sheathing—of which we shall have more to say on another occasion—the situation of magazines and facility of ammunition supply. Never before do we remember to have seen American designs thought out with so single an eye to the practical in all things. One may well contrast these new battleships with the Iowa, of 6000 tons less displacement. The Iowa has almost as much weight of armour, while in armament the chief difference is ten 7in. instead of six 4in.—a small matter of weight in 6000 tons. The new type ship will carry 2000 tons of coal normally, an increase of 1375 tons over the Iowa, and her horse-power, and consequently the weight of machinery, is increased. Still the 6000 tons is not to be made up with these things also, and there is indubitably a heavy balance expended in strength, in solid necessaries, that do not show on paper.

EXIT THE IMPERIAL INSTITUTE.

THE Executive Council of the Imperial Institute have finally decided to accept the logic of facts. The Imperial Institute as originally established ceases to exist. The building and exhibits and property of all kinds are to be handed over to the nation. The reason assigned is that the Board of Trade clashes with it. Lord James of Hereford makes the remarkable statement that its financial position is most satisfactory, and that its property is worth some half-million sterling. We have not the most remote idea what this means, or on what the valuation is based. The Institute was established to promote trade, against the advice of those engaged in trade and most competent to pronounce an opinion. Very large sums were obtained from India and abroad on the faith of promises which have not been kept. For this money no tangible return whatever has been made. The most charitable view that can be taken is that the undertaking was devised and mismanaged by amateurs, many of whom were perfectly honest and conscientious, but abysmally ignorant. From an early period the fact that the Institute was a failure became manifest. At one time it made a piteous appeal, *in formâ pauperis*, to escape paying taxes. For some two or three years it dragged out a precarious existence as a West End lounge, mainly supported by the Blue Hungarian Band. Some time ago it parted with a portion of its premises, and now the buildings are to be presented to the nation. The unfortunate members and shareholders have apparently not been consulted. The statement that it has been superseded by the Board of Trade is simply ridiculous. If the statement really expresses a truth, of what value to the nation can be the Imperial Institute? The Board of Trade undertakes none of the work which the costly buildings of the Institute were planned to serve. It provides no halls in which to exhibit samples. It has no council chambers in which high colonial officials were to discuss trade with the merchants and manufacturers of this country. The Imperial Institute was planned by men who see in technical schools and colleges a remedy for trade hindrances, difficulties, and troubles, with which these things have nothing whatever to do; and it enforces the old lesson, *Ne sutor supra crepidam*. Those who know nothing of the practice of international trade are not those qualified to say what is the best mode of developing it; nor are they the proper people to be entrusted with great sums of money to be expended in carrying out their ideas. We have never yet heard of any one outside a certain circle of officials deriving any benefit whatever from the Institute; and the only satisfactory circumstance about the present arrangement is that it will terminate the existence of a sham. It now remains to be seen whether "the nation" will accept the Institute, and what use can be made of the buildings.

LIMITATION OF SHIPYARD APPRENTICES.

A DECISION has now been arrived at on the apprentice question in shipyards on which employers and workmen may alike be congratulated. The result of a second ballot of the members of the Boilermakers' Society—a first ballot having, it was acknowledged, been indifferently treated by the workmen—is that, by a majority of 12,213, out of a total poll of 37,293, the Society has accepted the agreement proposed by the Shipbuilding Employers' Federation. The terms of this are to the effect that the employers are opposed to any limitation in the number of apprentices to be employed; but it is not their intention to overstock yards with apprentices, and if the Boilermakers' Society finds it necessary to prefer a complaint respecting the number of apprentices, this must be done through the secretaries of the Shipbuilding Employers' Federation. Apprentices are not "to be interfered with by any trade society," but "when requested by the Society, the secretaries of the Shipbuilding Employers' Federation will furnish a list of recognised apprentices, stating their names and ages, and also the time of their commencing their apprenticeship." The agreement, which is to remain in force for six years, only applies to shipyards, and does not affect premium apprentices.

INSTITUTION OF MECHANICAL ENGINEERS.

ON Friday evening, the 20th inst., a paper was read at the Institution of Mechanical Engineers on "The Microscopical Examination of the Alloys of Copper and Tin," by Mr. William Campbell. This paper, as pointed out by the President, is to be regarded as an appendix to the reports of the Alloys Research Committee. The experimental work was done some time ago when Mr. Campbell was in this country, but he had accepted a position in Columbia University, and had left before its entire completion. It has been carried on in a certain sense by Dr. Rose, whose remarks, touching a wholly practical note, formed perhaps the feature of the discussion.

The paper is devoted entirely to alloys of copper and tin. The experimental work has been done with a view to explain the complete freezing point curve of the copper-tin alloys, and to note the changes of structure due to casting. A complete series of alloys from 1 per cent. of copper up to 97½ per cent. has been studied, and the characteristic micrographical appearance was exhibited by lantern slides on the screen, and by excellent reproduction of these slides in the paper.

The subject as it stands is rather—if we may draw the distinction without being misunderstood—of a physical than an engineering character, and it is doubtful if it has more than a passing interest for the mechanical engineer, who finds, as Mr. Neville remarked, some difficulty in getting a general grasp of the subject. Whilst we have, therefore, a very high regard for the excellent work which Mr. Campbell has done, and a confidence that it may lead to results and assume a value which it is impossible to estimate at present, we do not propose reprinting his paper. Those who are interested in the subject will find in the excellent reproduction of the micrographs in the official copies all that they can desire. Sir William Roberts-Austen, Dr. Rose, Mr. Neville, and Mr. Milton sustained the discussion. Particular interest attaches to Dr. Rose's remarks on the micro structure of white metals. He showed by photographs on the screen how that if a specimen of white metal was rubbed and then examined with a microscope, certain star-like crystals could be seen standing up all over the surface. These, he explained, were hard crystals of SnCu, embedded in a softer matrix, and the value of anti-friction bearings was to be ascribed to their presence. Resting on the softer cushion below them, they readily conformed to the journal, and at the same time were hard enough to resist rapid wear. The same speaker also explained the object of quenching hot specimens, referred to frequently in the paper. A metal in the process of cooling passed through a variety of conditions. If it was desired to study any particular condition, the metal was suddenly cooled at the corresponding temperature, and the characters were, so to speak, stereotyped, and could be examined at ease.

An interesting diagram was shown on the screen by Mr. Neville. He had constructed it in conjunction with Mr. Heycock, and it was lately shown at the Royal Institution. The diagram consists of Sir W. Roberts-Austen's complete cooling curve of copper-tin alloys, with a second curve of the points of complete solidification, or melting points, drawn below it in the proper relative position. Alloys had fixed characteristics in different regions enclosed between these two curves.

Mr. Milton said that, in his opinion, one of the most valuable diagrams published by the Research Committee was that showing the cooling curves of each of the alloys examined. Sir W. Roberts-Austen on a previous occasion had shown the explanation of the remarkable breaks in the curves, and had pointed out that these breaks in the cases of pure metals were perfectly horizontal, whilst in impure metals they presented rounded corners or other curved forms. In his opinion this departure from the horizontal indicated that the successive portions of the metal solidifying were of different composition, and this view coincided with the fact stated by the author of the paper that the crystallites forming the yellow portions of gun-metal alloys were not of uniform composition throughout, but that they were richer in copper in their central portions. What happened was that at the temperature at which the break occurred a certain number of molecules of a definite compound of copper

and tin solidified when the temperature fell a few degrees. A few others solidified, but these were of a composition richer in tin than the other, and they doubtless formed a layer round those first solidifying, and so on, the grains thus gradually becoming larger by the growth round them of successive layers each richer in tin than the one on which it was deposited. In the cases of the alloys of the white type containing relatively small amounts of copper, he believed the same thing occurred. This was shown in two of the slides he would exhibit, and was corroborated by the author also. It was with some diffidence that he mentioned that his experience had in some respects led him to come to a different conclusion from the authors as to the structure of the alloys at the tin end of the series. The author appeared to think that with copper below 1 per cent., this metal existed combined with tin in the form of a eutectic; his slides, however, showed that the definite compound of tin and copper, which is so visible in alloys of about 8 per cent., existed, and could be clearly detected in alloys so poor in copper as to contain only one-quarter of 1 per cent. of that metal. He exhibited slides containing 13, 8, 4, 2, 1, ½, and ¼ per cent. copper, and one also of pure tin. The latter had been purposely deeply etched with nitric acid, and showed the same granular appearance as was in evidence in Mr. Campbell's views of the ½ and ¼ per cent. copper alloys, whilst the former showed the copper-tin compound, in each case in diminishing quantities. These were all slowly cooled by placing the small crucibles in which they were melted in a box containing silicate cotton. Referring to the influence of thermic treatment upon the structure of metals, Mr. Milton exhibited two slides of gun-metal, composed of 90 per cent. copper and 10 per cent. tin. One had been cast on a chill, the other had been allowed to cool slowly in the crucible. The size of the grains in the latter was fifteen times linear dimensions greater than those in the former. The influence of the rate of cooling was also shown by some slides of Babbit's and other white bearing metals, which, when slowly cooled, all showed considerably coarser structure than when in their normal condition. Two of the slides also showed that the white metals they represented, when slowly cooled, separated into layers of different constituents, the heavier settling to the bottom and the lighter floating upon it.

OUR NAVAL NEEDS.

THE Navy League, which lacks no vitality in the matter of manifestoes, has just issued a statement as to our naval needs. We have more than once pointed out in our columns that the Navy League has a tendency towards exaggeration upon occasions. In this particular case, however, it is not, on the face of things, absurd; and from its own particular point of view, its demand for twenty-one battleships is in no way preposterous. In all its wanderings the Navy League has succeeded in recognising one cardinal fact, that Germany is creating a navy with the more or less avowed object of one day trying a fall with us for the seas. That day may be yet far off, still there remains the fact that dreams exist of an extinction of Rule Britannia by Russia, France, and Germany. We seem, therefore, bound to be driven to meet that possible alliance, or to check it by exhibiting a readiness to meet it. It is a very old dream, conjured up by Napoleon in the first instance. Conditions have altered since then; but the continental combination against this country still exists as a possibility. Many hold it a mere bogie—a "Mary Jane," to quote the late Lord Beaconsfield. In a sense it may be; but the materials for the explosion seem always possible in that commercial war of which we have heard so much and felt so relatively little. The country is only just waking to the fact that, in spite of the wonderful talisman of technical education, by means of which Germany was wiping us out as a commercial factor, the wiping has been mostly this side of the North Sea. In return for this experience the Germans love us rather less than they did before, and the current flare-up over "British atrocities in South Africa" is a fairly heavy straw. All this makes for strained relations at some future date; while at the present time it is idle to pretend not to see that, but for the fleet Germany would probably have taken Mr. Kruger under her very ample wing. The Navy League manifesto says little beyond calling on us to face the inevitable, and, while we may, see to it that the fleet always exists as a factor in the way of Germany carrying out the ideals of people like Mr. Stead and the rest of the Pro-Boers. Sir H. Campbell Bannerman recently suggested in a characteristic speech that by "judicious surrender" war could always be avoided. This may be as true as the remark is novel to usually accepted ideas, but it is not the principle upon which things have been conducted hitherto, nor is it one that can give general satisfaction. Party politics aside, we conceive that a great many people hold strong views upon the matter. A "judicious surrender" of South Africa to Mr. Kruger would possibly bring immediate peace, so far as the Boers are concerned, but certain practical difficulties will suggest themselves to most people. And so elsewhere.

Now it is obvious enough that, if we object to the judicious surrender idea, we must have recourse to the old-fashioned idea of "hands off." To cry "hands off," we require a fleet able to follow words with deeds if necessary. Hence the demand for a fleet able to defeat any coalition likely to be formed. Neither Germany nor Russia is building ships for the fun of it. The one may have thought primarily of America, the other of Japan; but both the United States and Japan are meeting ships by ships, and all this tends to make us appear an alternative investment, a prospecting ground for those warships, unless, like America and Japan, we indicate—beyond all doubt—that the game is one at which two can play.

We do not love statistical tables, while we may say that, on paper, the British Fleet is at the present time fully a match for the three Powers, bearing in mind the fact that coalitions are difficult things to work, and that the members of coalitions invariably mistrust each other. We dislike alarmists, but ostrich-like tactics are equally objectionable. Neither the public nor the Navy League seem conscious of our "wear and tear" in ships, of neglected defects that culminate in worn-out ships. Thus, of the Channel Fleet, neither the Magnificent nor the Prince George—owing to the long neglect by the authorities of small original defects—is to be relied on for more than 13 knots. They do more only by virtue of tinkering. Then practically all the Royal Sovereign class need complete overhaul, which they have not had, and which, from sheer lack of substitutes, we cannot give. The same is true of the Trafalgars. All these ships are paying for overwork and neglected defects. We have worked them too hard and too long; they need replacing pending long months of overhaul.

This is our worst need. It may be demonstrated that it is no good building ships for which there is no *personnel*, but the question is not that. On paper we need, as it is, men for our ships; in sober fact, we also need ships for our men. In demanding a number of new ships, the Navy League is, therefore, right, not merely from its own point of view, but from interior points of view that it wots not of.

EXPERIMENTS UPON NOTCHED BARS.

THE results of some recent experiments upon notched bars, carried out by M. Charpy, and communicated to the Société des Ingénieurs Civils de France, possess some novel features of considerable interest. It is claimed that this particular type of test reveals qualities, defects, and weak points in the structural constitution of metals which ordinary tests fail to detect. It is not intended that these latter, consisting of the usual tensile, compressive, bending, and other trials of the material, are to be abandoned and superseded by the new method. On the contrary, the notched test is to be regarded as a kind of supplementary adjunct to the others, serving to compensate for their alleged insufficiency. It will be unnecessary to enter into the full description of the experiments to which we are referring. One instance will afford all requisite information.

From the same ingot of mild steel, and from as near as possible the same part of it, three groups of bars were selected of identical chemical composition. Each of these groups was submitted to an especial thermal treatment, and may be classed respectively as groups A, B, and C. When bars belonging to these groups—½in. in diameter and 4in. long between supports—were subjected to stresses of a tensile character, the following relations were established :—

Class of bar.	Elastic limit.	Maximum resistance.	Extension per cent.
A	22·7	33·7	37·5
B	23·1	34·5	36·0
C	33·0	43·6	29·5

Judging from this test alone, the bars classed as A and B may be considered similar in all respects. The metal in class C is of a much harder description. When bars of the same diameter and 1in. in height were exposed to compressive tests of a static nature, their elastic limits, taking them in the same order, were 36, 36·7, and 54·5. There is, again, but a very trifling difference in bars A and B, and, as before, class C retains its superior hardness. When these un-nicked specimens were tried by the shock, or drop, test, none of them suffered fracture, and they were all readily bent without showing any signs of fissures or cracks. So far, then, these tests failed to establish any marked discrepancy in the three groups of bars.

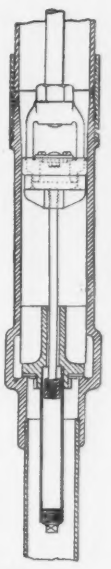
When, however, the specimens were notched or nicked, the difference became gravely accentuated. Bars were selected, 1¼in. by 1¼in. in section, with supports at a distance of 5in. apart. They were nicked to a depth of half their thickness, the nick being rounded at the bottom to a radius of ¼in. The monkey weighed 40 lb., with a fall of 9ft. In this experiment class A broke with five blows, and at a breaking angle of 45 deg. Class B gave way with a single blow, and at an angle of rupture of 165 deg.; while class C did not yield until it had received seven shocks; its fracturing angle was 52 deg. This angle is nearly the same as that belonging to class B, but the strength of the metal in C is greater, as it bore a couple of blows more than its neighbour. The material in the group B is obviously of a fragile character. It broke not only at the first blow, but also at a very large angle. This behaviour on the part of the metal denotes a dangerous degree of brittleness which was not rendered manifest by the preceding tests. It may be observed that a very close connection has been established between the results obtained in actual practice with marine crank shafts and the experiments upon notched bars.

In the employment of this new method there is one great difficulty which has not yet been surmounted. It arises from the well-proven fact that the different forms of notches at present in use produce totally different results in testing operations. It is, therefore, absolutely imperative to define strictly the precise form of the notch to be adopted. Numerous forms have been proposed, including the triangular, with either a sharp or rounded end; those made by a saw cut, by a planing machine, by a graver, or by the distinct pressure of a sharp instrument. M. Charpy proposes a form of notch terminating in a small cylindrical hole. It appears that the adoption of a notch, rounded at the extremity with a radius of sufficient length to ensure the accurate cutting of the curve, will answer satisfactorily for nearly all requirements. The other accessories of the testing operations, such as the dimensions of the specimens and the mode of fracture, are comparatively of little importance. Any ordinary pile driver will suffice for the purpose.

It is assumed as a *raison d'être* for the employment of the notched testing method, that the usual means of ascertaining the ductility of a metal are imperfect. They afford, it is stated, not the slightest indication of the breaking strength that the material possesses after its fibres, having suffered extension, are exposed to tortional stresses, or broken by a slight cut, crack, or fissure, in many cases scarcely perceptible. Another assumption, which is a corollary of the former, is that, consequently, we have no accurate information respecting two of the greatest risks to which all metallic structures are liable, particularly those of a riveted or built up type.

BORE TUBE PUMP.

A SERIOUS disadvantage in the use of a pump in a bore tube is the trouble that is frequently experienced in raising the suction valve in the event of its going wrong or giving trouble. In some cases the valve is provided with a screw at the top, and rods are lowered, the bottom end being furnished with a screw to fit it; this is a tedious process, and takes considerable time. Another method is to provide a ring on the top of the valve, and a rope is let down provided with a hook, and if luck favours the operator, the hook will engage in a ring and the valve may be raised.



In Merryweather's bore tube pump the difficulty is obviated by the device shown in the drawing annexed. A rod is screwed to the bottom of the bucket, the bottom end being provided with a nut, and the suction valve is made with a circular hole through the centre sufficiently large to allow the rod in question to pass through freely. A closed tube is fitted to the bottom of the suction valve to enclose the rod and nut. When the bucket is raised the nut engages with the bottom of the suction valve, which is thus brought to the surface with the bucket.

We understand that Merryweather and Sons fit this device to all pumps placed in artesian wells, but the apparatus is also applicable for ordinary sunk wells in cases in which the wells are in remote districts. One of these pumps has recently been erected at a farm on the estate of Mr. Arthur East, at Stockbridge, near Fullerton, with great success.

THE SIBERIAN RAILWAY.

IT may possibly prove interesting at the end of another year to review the progress being made of the Siberian Railway. The chief direction of the work of constructing the Trans-Siberian Railway was entrusted to a Committee appointed by a law passed on February 24th (March 8th) 1893, and presided over by the Heir-Apparent; since his accession his Majesty has remained president of this Committee, which is composed of the most prominent officials in the service of the State. This Committee was charged also with the work rendered necessary by the construction of the railway — for example, the colonisation of the zone traversed by the line. In the interests of locomotion, and from reasons of economy, the shortest route was traced out for the line, and hence the line runs for the most part below the 55th deg. of latitude, N. The various sections which would make up the line were divided into three groups, according to the urgency deemed necessary in their construction, and the work of construction was to be begun simultaneously at the two terminal points. It was resolved at the outset that the sections forming the first group should be completed by 1900; however, it was deemed advisable later to hasten simultaneously the construction of the sections in the first two groups, and thus it came to pass that in 1895 work was begun in constructing the Trans-Baikal line, and also that between Khabarovsk and Grafskaya.

At Chita, due eastwards of Lake Baikal, the line met the river Shilka, which, further east, becomes the Amur River, forming the North-Eastern frontier of Manchuria. Along the northern bank of the Shilka and of the Amur the line was taken, and in the Amur region immense technical difficulties were encountered in connecting the Trans-Baikal line with Vladivostock. Owing to these difficulties a treaty was concluded on August 27th (September 8th), 1896, between the Chinese Government and the Russo-Chinese Bank, and there was formed the Eastern China Railway Company, for the construction of a shorter line of railway across Manchuria. According to the terms of the Treaty, the projected line was to be built with a broad gauge similar to that of the Russian railways, and the working of the line was conceded to the company for a term of eighty years. The original project fixed the terminus of the Eastern China Railway at Pogranitchnaya on the Southern Ussuri line; but as a result of a Convention concluded on March 15th (27th), 1898, between Russia and China, and of the Protocol signed at St. Petersburg on April 15th (27th), 1898, concerning the lease of the ports of Port Arthur and Talien-Wan to Russia by China, the Eastern China Railway Company received the concession to construct a fresh branch line across Southern Manchuria.

Thus, in the fulness of time the Siberian Railway has obtained two openings on the Pacific Ocean, and the need of suitable communication with a port in the west has forced its way upon the attention of the authorities. Naturally enough the old port of Archangel was turned to account, and it was rendered accessible to the traffic of the Siberian Railway by constructing a railway northwards from Chéliabinsk to Ekaterinburg, a distance of 151 miles, by turning to account the existing line between Ekaterinburg and Perm, a distance of 160 miles, and by constructing the Perm and Kotlas line of 542 miles. This line was finished in 1898.

The rate of laying the light rails used was at the rate of more than a mile a day, for in less than nine years a distance of 3375 miles was laid. The Western Siberian line has been thrown open to regular traffic since October 1st (13th), 1896, and the other sections were thrown open as follows:—Krassnoyarsk and Irkutsk, January 1st (13th), 1896; Central Siberia, as far as Krassnoyarsk, January 1st (13th), 1898; Irkutsk to Lake Baikal and the Trans-Baikal, July 1st (14th), 1900; the Kaidolovo section, October 11th (24th), 1901; and the Eastern China Railway, October 21st (November 3rd), 1901. Uninterrupted train service from Moscow to Port Arthur will not be possible before the completion of the line around the southern end of Lake Baikal. This line is in course of construction and its total length will be 158 miles. Meanwhile, during the depth of winter an attempt is made to carry on the passenger traffic across the frozen surface of the lake by means of sledges, and during the rest of the year the service is maintained by huge ice-breaker steam ferries, which transport the trains across the lake.

A WORKMEN'S TIME RECORDER.

MANY firms, especially those employing a large number of hands, have for some years past found it expedient to provide, at the workmen's entrance, some kind of apparatus capable of recording on time cards the time of entrance and exit of each workman. The general practice is to place a time recorder and two card racks in such a position that each workmen on entering the works takes his time card from the first rack he comes to and places it in the recorder, and, by pushing a handle or knob, registers his time thereon, after which he deposits the time card in the other rack and passes into his work; his time on leaving the works is printed on his card by the same process. At the end of the week the time is totalled up and amount of wages computed. Though much skill and thought have been expended on these machines, fraud, up to now, has been more or less possible, due to the fact that during the time the workman has been recording his time the card has never necessarily been out of his possession. The accompanying drawings, however, show a recorder with which it is estimated fraud will be an impossibility; inasmuch as the card, when placed in the slot, immediately disappears out of sight and out of control of the workman, on his attempting to record his time thereon. In fact, no printing whatever can be done while any portion of the card is visible, and it will also be seen that no printing can be done should the card be put in the recorder the wrong way about.

Fig. 1 shows the general external appearance of the recorder, which consists of a case containing an ordinary clock movement with face, a type sector, and two type wheels, a vertically-moving card carrier working in guides, an automatic inking ribbon, printing lever and pad, a series of holes in casing for determining the position on which the card is to be printed, and a sliding shutter at the mouth of the card slot for the purpose of determining the side of the card to be printed upon.

Fig. 2 shows the general arrangement of the mechanism, the clock face and casing being omitted. The type employed represents the day of the week, the hour—p.m. or a.m.—and the minutes. All these types are brought up into alignment by, and read in unison with the clock. Thus it will be observed that the hands in drawing show 17 minutes past 2 p.m. on Monday, which prints the card thus: P. 2. 17. M. The day-of-the-week type are carried on a sector, which is actuated by the specially-constructed snail cam shown at the top of the clock movement; a cog wheel revolving once every twenty-four hours is provided with two pins, which engage in the teeth of the ratchet wheel, and revolve the above-named snail cam, which two latter are fixed on the same spindle, moving it to the extent of one step, each step representing a separate day of the week. A vertical rod bent at the top, so as to rest upon the snail cam, is connected with the sector by a lifting link; this sector and link are shown to a larger scale in Fig. 3. Thus, on Sunday night, the sector will be up in its highest position, with the letter S in the printing line; therefore, as soon as midnight arrives, the snail cam releases the vertical rod, which allows the sector to fall to its lowest position, bringing M for Monday into the printing line. The minutes type wheel is fixed on a spindle, which is set to make one complete revolution each hour, through the medium of a shorter vertical rod geared thereto at the bottom with a crown wheel, and at the top by another crown wheel gearing with the clock movement; this spindle and type wheel are shown in Fig. 3. The type wheel for the hour type, with driving ratchet attached, is loose upon the spindle, and is driven by means of the locking escapement as shown in Fig. 4. The spindle in Fig. 3 is identical with that shown in Fig. 4. This type wheel is provided with type denoting every hour of the day and night, distinguished by a P for p.m. and an A for a.m., and is required to bring a fresh number into the printing line every hour. This is accomplished in the following manner:—A snail cam fixed to the spindle revolves once every hour, lifting the locking escapement, which, when released, falls. The spring pawl engages the teeth of the ratchet and forces the type wheel round to the extent of one hour type. The locking escapement is also provided with escapement pins—Fig. 5—so arranged that each time it falls only one pin of the ratchet may pass. Two other spring pawls ensure correct alignment of the type.

Fig. 6 is a part sectional plan of the printing arrangement, which consists of a printing lever pivoted upon a short spindle, which is bored axially to receive the elongated pin

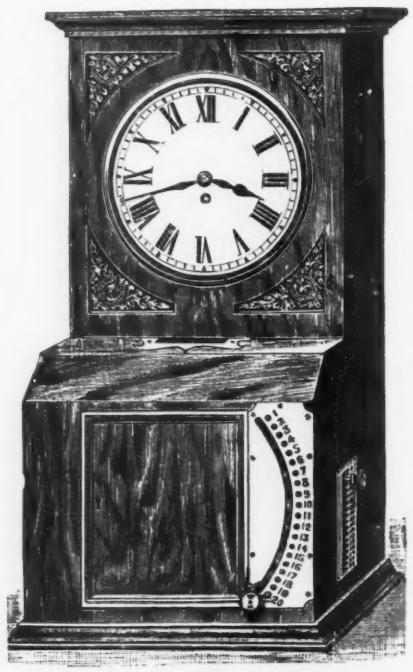


Fig. 1—THE STOCKALL TIME RECORDER

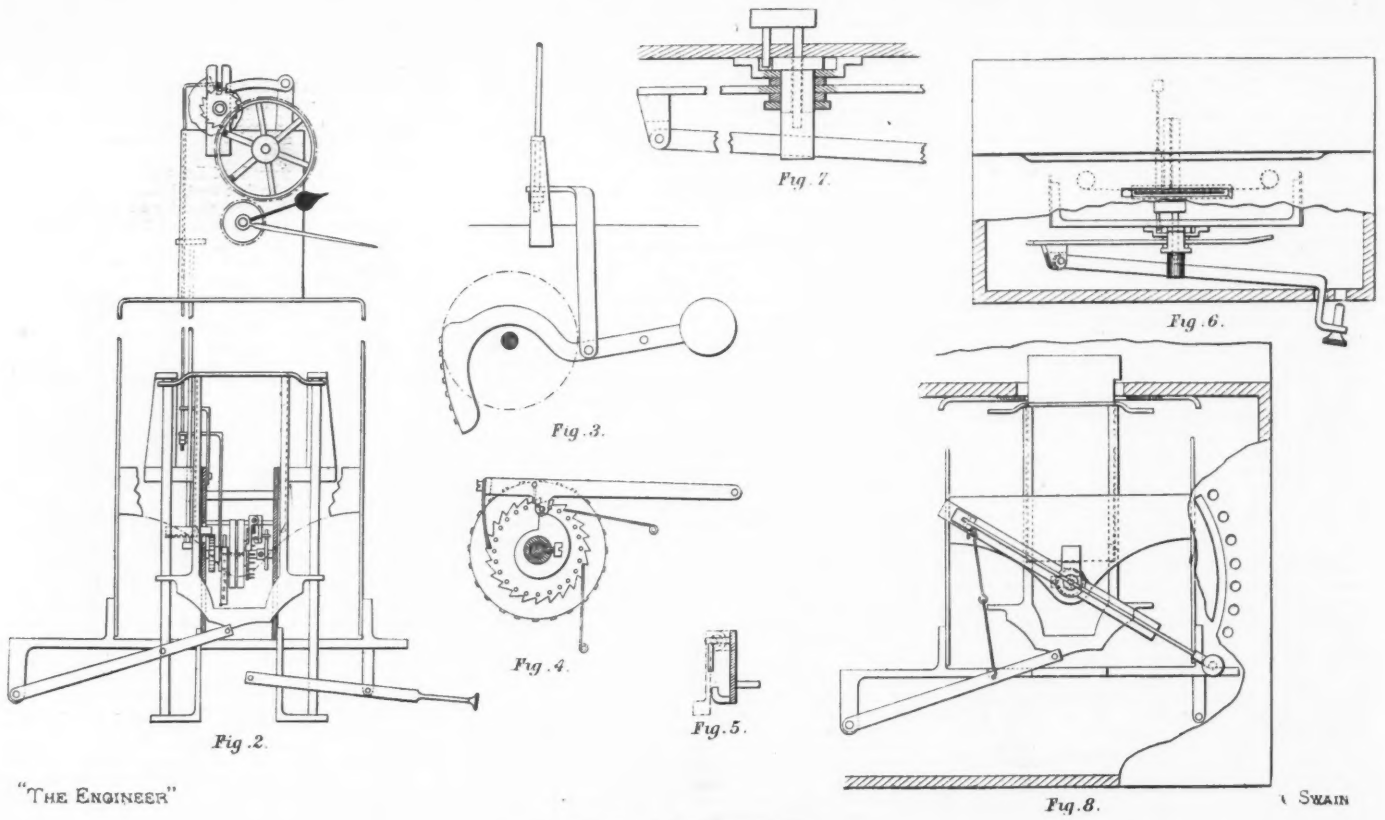
of the printing pad. Fig. 7 is an enlarged view of the printing lever pivot and pad.

Fig. 8 is an elevation of the printing lever—card carrier guides omitted—and slide for reversing card. The action is as follows:—The workman drops his time card into the slot, which falls into the card carrier to the position indicated in drawing; in this position it will be observed that the bottom of the card is above the printing line. He then raises the push handle, or exposed extremity of the printing lever, till the peg comes opposite one of the holes in the casing. he then presses the push handle home, the effect being to force the printing pad against the back of the card, which forces the front of the card against the type—the printing ribbon intervening—thus printing the time shown on the clock. It will be observed that the bottom of the card carrier rests upon a projection on a lever which is suspended by links hooked to a prolongation of the printing lever; it is then that when the knob or push handle and peg are raised to come opposite one of the holes, the opposite end of the printing lever falls, and allows the card carrier to fall, also taking the card into the machine out of sight and control of the workman. All the holes are covered up except the proper hole for the day, which determines the position on the card where the printing is to be done. The cards are made with a slight projection on one side at the top; in the sketch the card is shown placed in the recorder with the projection to the right; the slide is also shown to the right. The card would therefore clear the slide and pass down with the carrier. Should it, however, be placed in the recorder the wrong way about, that is, with the projection to the left, the card would not pass into the interior of the recorder; the card-carrier would descend without it, leaving it suspended by the projection upon the slide; thus pushing the slide, which is not under control of the workman, to the right or to the left, determines which side of the card is to come in contact with the type. J. J. Stockall and Sons, of 10, Clerkenwell-road, London, are the makers of the above described recorder.

A NEW SPEED COUNTER.

WE have just had brought to our notice by O. Berend and Co. a new form of speed counter. This apparatus appears to embody everything which could possibly be required in connection with counting the number of revolutions during a given time. It has two faces, one at each side, the one dealing with the revolutions, the other with the time. The revolution face has three dials. The first, which occupies the whole face, is for recording the separate revolutions up to 100. The second dial is very much smaller, and is contained on the right-hand side within the large dial. This second dial is divided into ten divisions, each division representing 100, or one complete revolution of the pointer on the large dial. It can, therefore, record up to 1000 revolutions. A third dial, also small in size, occupies a position on the left-hand side similar to that on the right already described. This dial also is divided into ten divisions, each one of which represents a complete revolution of the second dial, or a total of 10,000. As in former instruments of a similar character made by this firm, there is an arrangement by which it can be seen at a glance in which direction the pointers have been moving on the dials, and hence which readings to take—in other words, the apparatus works equally well no matter in what direction the machine, the revolutions of which are being counted, is revolving. The means employed are to have a small opening in the dial; if the revolutions are in one direction a red disc appears beneath this opening; if in the other, a black disc. The dials are provided with both black and red figures, so that readings are quite easy. A small lever placed at the rim on being touched sends the pointers of the two smaller dials back to zero, and the pointer of the big dial can be adjusted by means of a small hand screw which is also connected to the pointers of the smaller dials, so that all three dials may be set at any required point.

On the other side of the apparatus are two dials. One, the larger, is exactly similar to a centre seconds watch, one complete revolution of the pointer equalling one minute. The other dial is small, and is divided into thirty divisions, each one representing one minute. In this case also a small lever sends the pointers of both dials back to zero. The clockwork is actuated by means of a spring, which can be wound up by turning a small thumb screw. The driving spindle, unless pressed well home against the revolving shaft, the revolutions of which it is desired to take, is simply carried round without doing anything. At the instant, however, that it is pressed against the shaft the watch mechanism starts and the counting begins, and, of course, at the instant the apparatus is withdrawn all motion ceases again. This enables the driving rubber attachment, or whatever other arrangement of the kind is employed, to be put in position at the end of the shaft before counting begins. We understand that the mechanism has been constructed with a view to taking speeds up to 6000 revolutions per minute.



DETAILS OF THE RECORDER

BATTERY OF DROP STAMPS

B. AND S. MASSEY, MANCHESTER, ENGINEERS

A BATTERY OF DROP STAMPS.

WE reproduce above a photograph of a set of Brett drop stamps, recently constructed by B. and S. Massey, of Manchester, for the East Indian Railways. The illustration shows a battery of three stamps, 7 cwt., 15 cwt., and 25 cwt. respectively, and is to form part of the plant in the locomotive repair shops. These drop stamps can be worked either by steam or compressed air, and the power directly applied. Amongst their advantages are fewness of working parts and great speed of working. As will be seen, the lifting mechanism is carried by long iron girders, supported by end stanchions, independently of the base block, and is thereby protected from shock and vibration. The lifting mechanism is one of the special features of the stamp, and in its construction the shaft, levers, and piston are fastened together so as to form practically one solid piece, which is the only working part, and is free to rotate about three-quarters of a revolution in the cylinder. The cylinder contains a division piece, which is securely bolted to one side. The bearings in which the shaft runs are long, to give ample wearing surface, and are made steam-tight by ordinary stuffing-boxes. Packing strips are placed in grooves in three sides of the piston and in the division pieces, and are pressed outwards by springs to keep the piston steam-tight. The pulley is strongly made of wrought iron, and turns freely on the shaft between the levers. The outer ends of the arms, which reach just beyond the rim of the pulley, are connected by a cross bar, to which the lifting belt is connected. When steam is admitted between the division piece in the cylinder and the piston, the shaft and the tup are lifted, and when the exhaust is opened the hammer falls with its full weight, and the shaft returns to its former position. The guide bars of the stamps are made exceptionally strong, with accurately planed V slides. The lower ends, which are adjusted by screws, rest in tapered recesses in the base block, and being free to move vertically, cannot transmit vibration to the lifter. The upper ends are adjusted by wedges. The lower die is held and adjusted by four strong poppet screws, or, if required, is arranged to be held in a dovetail opening in the base block. The base block is of massive construction, generally about fourteen times the weight of the tup. The stamp is single-acting, the tup being lifted by the belt attached to the lifter, and falling freely with its full force, the blows given being of the elastic nature best suited to stamping and under perfect control, as in a kick stamp, but much quicker. The valve gear is hand-worked, the length of stroke being variable at will by the movement of the hand lever, and a boy can operate even the largest stamp.

THE Midland Railway Company has appointed Mr. R. M. Deeley, of the locomotive department, to succeed Mr. John Lane as works manager of that department at Derby, and Mr. Cecil Paget has been selected as assistant-manager. Mr. Lane has held the post since the death of Mr. Holt some ten years ago, and retired in accordance with the company's regulations in respect of the age limit. Mr. Deeley has been associated with the locomotive department about twenty-five years.

RECENT ADMIRALTY SURVEYS.

IN England, as in all important maritime nations, of which she is admittedly the chief, the study of hydrography, or that particular branch of physical geography which treats of the natural features of rivers, seas, and oceans, is a matter of State culture. An accurate account of the configuration of land and water in all parts of the world, a reliable record of all soundings, shoals, currents, and rocks, which beset ships on their voyages, is essential to the safety of those whom they bear over the deep. In addition, the preparation and construction of the numerous plans and charts is of inestimable service to the sailor and the navigator. An official account of the hydrographical surveys which have been in progress during last year has been recently issued from the Government Press,* and will well repay perusal. The surveys are classed under the two heads of "Home" and "Foreign." Of these, the former comprises the coast-line, estuaries, and rivers of the United Kingdom; and the latter relates to the same physical features in Africa, Australia, China, Newfoundland, and North America.

On the south coast the bar of Portsmouth Harbour was partially re-sounded, and the general depths were found to be about 29ft., which is from 1½ft. to 2ft. greater than that indicated by the survey of three years ago. There were also some very remarkable deep holes discovered, with as much as 35ft. of water in them. There was, therefore, not only during this interval of time a total absence of all shoaling and silting up, as is so frequently and so annoyingly evident in subsequent surveys, but good testimony to the force of the current and the scour of the tide, and also to the movable character of the material forming the bed of the waterway. This bar is principally composed of shingle, and was dredged out in 1894 to a depth of 29ft. About a couple of years afterwards it had shoaled to 27ft. This diminution in the depth was probably due to the enfiltration or washing in of the shingle from the side slopes of the excavation. The present depth, however, points out that the strength of the stream is mainly directed to and working upon the lower part of the bar. It will be interesting to learn from future surveys what the eventual result has been. In the neighbouring entrance to the channel a considerable area was closely searched in endeavouring to discover a reported new sandbank. No indication of any kind of the reported obstruction could be found, although the submarine sentry was kept continuously towing at a depth varying from 40 to 45 fathoms. Before leaving for the west coast of Ireland the surveying vessel H.M.S. Research proceeded to Ushant. The object of the visit was to carry out, at the request of the Royal Society, a series of zoological experiments and investigations in deep water about 150 miles south-westward of that island. The purport of the observations was to ascertain by means of self-closing nets the vertical limits at which various forms of marine life exist.

Several test lines of soundings were run across the river Shannon in various places to determine whether any alterations of importance had taken place since the date of the original survey of 1841. With one exception the result was very satisfactory, as the changes discovered were of a trifling amount. The exception consisted in the appearance of a shoal in the channel above Foynes, which had not been previously recorded and charted. At Kinsale the survey of the harbour was completed on the 6in. Ordnance scale, and the triangulation along the Kenmare River. Lines of soundings were run across the river, intersecting those of an earlier survey, to detect any changes that might have occurred. On the whole, the discrepancies were unimportant; but a couple of small and dangerous shoals were located, previously unregistered, which sufficiently indicate the necessity of further close and continual research in hydrographical surveying operations.

There is nothing particular to note respecting the visit to the east coast of England. It may be mentioned that at Dover, where great pier and harbour extensions are in progress, an examination was made of the depths between the Admiralty and the East piers, with observations on the tidal streams. A deposit of silt, resulting from the stage reached by the advancing works, was found between the ends of the two piers. As the Admiralty Pier is prolonged seawards this deposit will probably cease; if not, it is an easy matter to remove it. At Plymouth, by the completing of the dredging at Cremill, a depth of 30ft. was obtained, and this improvement, together with the removal of the Vanguard and Rubble shoals, materially facilitates the entrance to the Hamoaye. A re-sounding of the river Tyne proved that great changes had taken place in the depth of the river, after the dredging operations by the Tyne Improvement Commission, which are still being proceeded with. A general depth of 22ft. to 28ft. was reached at low-water ordinary springs, and connections were established between the Ordnance bench marks and the tide gauges of the Improvement Commission.

Turning to the second, or "Foreign" division, of the surveys, it will be observed that under the heading of Australia are included the north-west and south-west coasts and Queensland. During the voyage of the Penguin, at the beginning of the year, some deep-sea soundings were obtained at regular intervals, 130 miles apart, and a maximum depth obtained of 18,240ft. Great as this depth is, it has been surpassed by the soundings of the Tuscarora, which registered 28,000ft. In the neighbourhood of the island of Tonga, in the Pacific Ocean, 29,000ft. have been reached, and the greatest sea depth ever obtained has been put at 31,000ft. No indication of shallow water could be traced in the Gulf of Carpentaria, and a search made for the "Indus Reef" was ineffectual, though carried over an area of 120 square miles. In this locality many new shoals, dangerous to navigation, were discovered, and the observations have verified or disproved many shoals which have long been doubtful. The whole of the operations constitutes a very important, valuable, and careful piece of work. After determining the latitude of the North-west Cape and the meridian distance between it and Ashburton Roads, the survey was commenced of the Recherche Archipelago, for the purpose of rendering the navigation safe to vessels approaching Esperance Bay from the eastward. This survey covers an area of 1500 square miles, and its execution revealed many new and hidden dangers. Advantage was taken of the passage from Albany to Esperance Bay to obtain many additional lines of soundings, and to connect the work of the previous year with that of the Recherche Archipelago. In Queensland the survey of Princess Charlotte Bay was finished, and that of Bathurst Baz continued, while the ship proceeded to search for the "Wikengen Reef." A shoal having three fathoms least water at L.W.O.S., and four to five fathoms general depths, was found in almost an identical position with the five and a half fathoms reported by H.M.S. Patuma. Although situated further north, this appears to be the "Wigengen Reef," already searched for unsuccessfully on two previous occasions.

The surveying operations in China comprised the continuation of the triangulation of Hong Kong to the westward towards Canton, and the sounding of the shallows of the Northern Channel into the Yangtse, as the Southern Channel had lately shoaled so considerably as to render it unsafe to bring large ships through it. Ultimately a very good channel was selected, carrying a minimum depth of 26ft. at low-water springs, and the course for vessels was marked out by buoys. In Africa, the west coast of Cape Peninsula was laid down on a scale of one inch to the mile. This is an undertaking which has been a desideratum for a good many years. The existing plan of Simon's Bay was thoroughly revised and brought up to date. Durban was visited with a similar object in view, and a survey of the Pungue River, near Beira, was put in hand. This work has been very much needed, as the port has rapidly developed since the discovery of the navigability of its entrance, some fifteen years ago, and is at present of great importance in connection with the trade of Rhodesia. The next work in these waters was the preparation of a plan of the harbour of Zanzibar, as well as of the narrows of the Southern Pass, where several coral heads were found, one with only 14ft. of water, in a very dangerous position in the channel. A chain of magnetic observations for variation was made at sea on the east coast of Africa, off Durban, Beira, Mozambique, Zanzibar, Guardafui, and the Arabian coast. These fully demonstrated that considerable alterations had taken place of late years in the rate of change of this important magnetic element. A work which has also for some time been much called for was undertaken. It was a survey of the Arabian coast from the Island of Perin, eastwards to Ras Kaan, to enable a larger scaled chart to be published of the much frequented Strait of Bab el Mandeb and its approaches. Recent events have undoubtedly brought strongly into notice the future possibilities of all African ports, and the maritime importance of its great coast line.

The useful and important information relating to all quarters of the globe, which the Admiralty receives from the hydrographical departments of foreign Governments, from the Indian, Colonial, and other authorities, and from the British consuls, and captains of the Royal as well as of the merchant Navy, materially conduce to the success of its efforts. One of the results of this information, combined with its own field and office work, is to be found in the fact that the number of charts printed by the Admiralty for the requirements of the Royal Navy, for Government departments, and to meet the demand of the general public, has during the year 1900 amounted to 580,207.

* Report by the Hydrographer of the Admiralty of the work performed under the direction of the Lords Commissioners of the Admiralty during the year 1900, in the examination and charting of the seas and coasts in various parts of the globe.

HIS Majesty the King, who already possesses two 12 horse-power Daimler motor cars, has, we understand, ordered a 22 horse-power car of the same build. It will embody a number of special features.

AMERICAN BRIDGE SPECIFICATIONS.

We conclude the reprint of an American bridge specification, the first part of which appeared in our last issue.

DETAILS OF CONSTRUCTION.

(52) All truss bridges shall be given a proper camber.

(53) All sections shall preferably be made symmetrical, and the pins placed in the line of the neutral axis.

(54) Adjustable members in any parts of structures shall preferably be avoided.

(55) All through spans shall have stiff end vertical suspenders.

(56) The heads of eye-bars shall not be less in strength than the body of the bar.

(57) All nuts must be of hexagonal shape.

(58) All lateral and sway bracing shall preferably be made of shapes which can resist compression as well as tension.

(59) All through spans with top lateral bracing shall have portals at each end of span, connected rigidly to end posts. They shall be as deep as the specified head room will allow, and provision shall be made in the end posts for the bending strains produced by the wind pressure.

(60) Deck bridges shall have diagonal braces at each panel, of sufficient strength to carry half the maximum strain increment due to wind and centrifugal force, if any.

(61) Pony trusses and through plate girders shall be stayed by knee braces or gusset plates at the ends, and at each floor beam or transverse strut.

(62) Provision shall be made for a free expansion and contraction of all parts, corresponding to a variation of 150 deg. Fah. in temperature.

(63) All bridges exceeding 100ft. in length shall have hinge bolsters on both ends, and at one end nests of turned friction rollers, running between planed surfaces. Rollers will not be less than 3in. in diameter; and the pressure per lineal inch of roller, including impact, shall not exceed $1200\sqrt{d}$ for steel rollers between steel surfaces (d = diameter of roller in inches).

(64) For bridges less than 100ft. in length, one end shall be free to move upon smooth surfaces.

(65) Bed-plates shall be so proportioned that the pressure upon masonry, including impact, will not exceed 400 lb. per square inch.

(66) The pitch of rivets in the direction of the strain shall never exceed 6in., nor 16 times the thickness of the thinnest outside plate connected, and not more than 50 times that thickness at right angles to the strain.

(67) At the ends of compression members the pitch shall not exceed four diameters of the rivet, for a length equal to twice the width of the member.

(68) The distance from the edge of any piece to the centre of a rivet hole must not be less than $1\frac{1}{2}$ times the diameter of the rivet, nor exceed 8 times the thickness of the plate; and the distance between centres of rivet holes shall not be less than three diameters of the rivet.

(69) The butt joints of compression members shall be connected by splices to hold them truly in position; all other joints in riveted work, whether in tension or compression, must be fully spliced.

(70) All segments of compression members connected by latticing only shall have tie plates placed as near the ends as practicable. They shall have a length of not less than the greatest depth or width of the member, and a thickness not less than $\frac{1}{50}$ of the distance between the rivets connecting them to the compressed members.

(71) Single lattice bars shall have a thickness of not less than $\frac{1}{40}$, and double bars connected by a rivet at the intersection of not less than $\frac{1}{50}$ of the distance between the rivets connecting them to the member; and their width shall be in accordance with

Shearing and Bearing Value of Rivets in Pounds.

Diam. of rivet. Inches. Fraction.	Diam. of rivet. Inches. Decimal	Area in square inches.	Single shear at 11,000 lb	Bearing value for different thicknesses of plate in inches at 22,000 lb. per square inch.											
				$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1
$\frac{3}{8}$	·375	·1104	1210	2060	2580	3090										
$\frac{1}{2}$	·500	·1963	2160	2750	3440	4130	4820	5,500								
$\frac{5}{8}$	·625	·3068	3370	3440	4300	5160	6020	6,880	7,740	8,600						
$\frac{3}{4}$	·750	·4418	4860	4130	5160	6190	7220	8,250	9,280	10,320	11,340	12,380				
$\frac{7}{8}$	·875	·6013	6610	4810	6020	7220	8430	9,630	10,840	12,040	13,240	14,440	15,640	16,840	18,050	
1	1·000	·7854	8640	5500	6880	8250	9630	11,000	12,380	13,750	15,130	16,500	17,880	19,250	20,630	22,000

All bearing values above or to right of upper Zigzag Lines are greater than double shear.
Values below or to left of lower Zigzag Lines are less than single shear.

American Bridge Company's standards generally:—

For 15in. channels or built sections with 3½in. and 4in. angles.	2½in. (⅞in. rivets).
For 12in., 10in., and 9in. channels or built sections with 3in. angles.	2in. (⅞in. rivets).
For 8in. and 7in. channels or built sections with 2½in. angles.	2in. (⅞in. rivets).
For 6in. and 5in. channels or built sections with 2in. angles.	1½in. (⅞in. rivets).

(72) All pin holes shall be re-enforced by additional material when necessary, so as not to exceed the allowed pressure on the pins. These re-enforcing plates must contain enough rivets to transfer the proportion of pressure which comes upon them, and at least one plate on each side shall extend not less than 6in. beyond the edge of the tie plate.

(73) Web plates of girders must be spliced at all joints by a plate on each side of the web capable of transmitting the full strain through splice rivets.

(74) The flange plates of all girders must be limited in width so as not to extend beyond the outer lines of rivets connecting them with the angles, more than 5in. or more than eight times the thickness of the first plate. Where two or more plates are used on the flanges they shall either be of equal thickness or shall decrease in thickness outward from the angles.

WORKMANSHIP.

(75) All riveted work shall be punched accurately with holes $\frac{1}{16}$in. larger than the size of the rivet, and when the pieces forming one built member are put together, the holes must be truly opposite; no drifting to distort the metal will be allowed; if the hole must be enlarged to admit the rivet, it must be reamed.

(76) All holes for field rivets in floor beam and stringer connections and splices in tension members shall be accurately drilled to an iron templet or reamed while the connecting parts are temporarily put together.

(77) In medium steel over $\frac{3}{4}$in. thick, all sheared edges shall be planed, and all holes shall be drilled or reamed to a diameter of $\frac{1}{4}$in. larger than the punched holes so as to remove all the sheared surface of the metal.

(78) The rivet heads must be of approved hemispherical shape, and of a uniform size for the same size rivets throughout the work. They must be full and neatly finished throughout the work, and concentric with the rivet hole.

(79) All rivets when driven must completely fill the holes, the heads be in full contact with the surface, or countersunk when so required.

(80) Wherever possible, all rivets shall be machine driven. Power riveters shall be direct-acting machines, worked by steam, hydraulic pressure, or compressed air.

(81) When members are connected by bolts which transmit shearing strains, such bolts must have a driving fit.

(82) The several pieces forming one built member must fit closely together, and when riveted shall be free from twists, bends, or open joints.

(83) All portions of the work exposed to view shall be neatly finished.

(84) All surfaces in contact shall be painted before they are put together.

(85) The heads of eye-bars shall be made by upsetting, rolling, or forging into shape. Welds in the body of the bar will not be allowed.

(86) The bars must be perfectly straight before boring.

(87) The holes shall be in the centre of the head and on the centre line of the bar.

(88) All eye-bars shall be annealed.

(89) All abutting surfaces in compression members shall be truly faced to even bearings, so that they shall be in such contact throughout as may be obtained by such means.

(90) The ends of riveted floor girders shall be faced true and square.

(91) Pin holes shall be bored truly parallel with one another, and at right angles to the axis of the member, unless otherwise shown in the drawings; and in pieces not adjustable for length, no variation of more than $\frac{1}{32}$in. for every 20ft. will be allowed in the length between centres of pin holes.

(92) Bars which are to be placed side by side in the structure shall be bored at the same temperature, and shall be of such equal length that, upon being piled on each other, the pins shall pass through the holes at both ends at the same time without driving.

(93) All pins shall be accurately turned to a gauge, and shall be straight and smooth.

(94) The clearance between pin and pin hole shall be $\frac{1}{32}$in. for pins up to $3\frac{1}{2}$in. in diameter, which amount shall be gradually increased to $\frac{1}{32}$in. for pins 6in. in diameter and over.

(95) All pins shall be supplied with steel pilot nuts, for use during erection.

(96) All workmanship shall be first-class in every particular.

STEEL.

(97) All steel must be made by the open-hearth process, and if by acid process, shall contain not more than ·08 per cent. of phosphorus, and if by basic process, not more than ·05 per cent. of phosphorus, and must be uniform in character for each specified kind.

(98) The finished bars, plates, and shapes must be free from injurious seams, flaws, or cracks, and have a clean, smooth finish.

(99) The tensile strength, limit of elasticity and ductility, shall be determined from a standard test piece, cut from the finished material, of at least $\frac{1}{2}$ square inch section. All broken samples must show a silky fracture of uniform colour.

(100) Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

(101) Every finished piece of steel shall be stamped with the blow number identifying the melt.

(102) Steel shall be of three grades: Rivet, soft, and medium.

(103) Rivet steel shall have ultimate strength, 48,000 lb. to 58,000 lb. per square inch; elastic limit, not less than one-half the ultimate strength; elongation, 26 per cent.; bending test, 180 deg. flat on itself, without fracture on outside of bent portion.

(104) Soft steel shall have ultimate strength, 52,000 lb. to 62,000 lb. per square inch; elastic limit, not less than one-half the ultimate strength; elongation, 25 per cent.; bending test, 180 deg. flat on itself, without fracture on outside of bent portion.

(105) Medium steel shall have ultimate strength, 60,000 lb. to 70,000 lb. per square inch; elastic limit, not less than one-half the ultimate strength; elongation, 22 per cent.; bending test, 180 deg. to a diameter equal to thickness of piece tested, without fracture on outside of bent portion.

(106) Full size test of steel eye-bars shall be required to show not less than 10 per cent. elongation in the body of the bar, and tensile strength not more than 5000 lb. below the minimum tensile strength required in specimen tests of the grade of steel from which they are rolled. The bars will be required to break in the body, but should a bar break in the head, but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection, provided not more than one-third of the total number of bars tested break in the head; otherwise the entire lot will be rejected.

(107) Pins made of either of the above-mentioned grades of steel shall, on specimen test pieces cut from finished material, fill the requirements of the grade of steel from which they are rolled, excepting the elongation, which shall be decreased 5 per cent. from that specified.

(108) Punched rivet holes, pitched two diameters from a sheared edge, must stand drifting until the diameter is one-third larger than the original hole, without cracking the metal.

(109) The slabs for rolling plates shall be rolled from ingots of at least twice their cross-section.

(110) Pins up to 7in. diameter shall be rolled.

(111) Pins exceeding 7in. diameter shall be forged under a steel hammer striking a blow of at least 5 tons. The blooms to be used for this purpose shall have at least three times the sectional area of the finished pins.

(112) A variation in cross-section or weight of rolled material of more than 2½ per cent. from that specified, may be cause for rejection.

(113) Steel castings shall be made of open-hearth steel containing from ·25 to ·40 per cent. carbon and not over ·08 per cent. of phosphorus, and shall be practically free from blow holes.

(114) Except where chilled iron is specified, all castings shall be of tough, gray iron, free from injurious cold shuts or blow holes, true to pattern, and of workmanlike finish. Test bars 1in. square, loaded in middle between supports 12in. apart, shall bear 2500 lb. or over, and deflect 0·15in. before rupture.

TIMBER.

(115) The timber shall be strictly first-class spruce, white pine, Douglas fir, Southern yellow pine, or white oak bridge timber; sawed true and out of wind, full size, free from wind shakes, large or loose knots, decayed or sapwood, wormholes or other defects imparing its strength or durabiilty.

PAINTING.

(116) All ironwork before leaving the shop shall be thoroughly cleaned from all loose scale and rust, and be given one good coating of pure boiled linseed oil, well worked into all joints and open spaces.

(117) In riveted work, the surfaces coming in contact shall each be painted before being riveted together.

(118) Pieces which are not accessible for painting after erection shall have two coats of paint.

(119) The paint shall be of good quality of oxide of iron paint, mixed with pure linseed oil, or such as may be specified in contract.

(120) After the structure is erected, the ironwork shall be thoroughly and evenly painted with two additional coats of paint, mixed with pure linseed oil, of such quality and colour as may be selected.

(121) Pins, pin holes, screw threads, and other finished surfaces shall be coated with white lead and tallow before being shipped from the shop.

INSPECTION.

(122) All facilities for inspection of material and workmanship shall be furnished by the contractor to competent inspectors, and the engineer and his inspectors shall be allowed free access to any part of the works in which any portion of the material is made.

(123) The contractor shall furnish, without charge, such specimens—prepared—of the several kinds of material to be used as may be required to determine their character.

TESTING.

(124) Full sized parts of the structure may be tested at the option of the purchaser; but, if tested to destruction, such material shall be paid for at cost, less its scrap value, if it proves satisfactory.

(125) If it does not stand the specified tests, it will be considered rejected material, and be solely at the cost of the contractor, unless he is not responsible for the design of the work.

The specification is accompanied by tables of uniform live load, maximum moments, maximum end reactions, &c. They are too bulky for reproduction here. We give, however, one.

THE INSTITUTION OF CIVIL ENGINEERS.

MOTIVE POWER FROM BLAST-FURNACE GASES.

At the ordinary meeting on Tuesday, the 17th of December, 1901, Mr. Charles Hawksley, president, in the chair, the paper read was "Motive Power from Blast-furnace Gases," by Bryan Donkin, M. Inst. C.E.

The author considered first the importance of the discovery made within the last few years, that power could be produced economically and effectively by utilising the gases from blast furnaces to drive gas engines. As the annual production of iron from blast furnaces throughout the world was 40 million tons, this new application of motive power was capable of immense development. The gases given off from these furnaces during the process of smelting iron were practically the same as weak producer-gas. Till within about half a century they had all been wasted. A part was next utilised under boilers to generate steam to drive the blowing engines, and part to heat the air-blast; but after supplying these requirements, a considerable surplus was available. Successful efforts had been made, first to use this surplus in gas-engine cylinders, to obtain power, and next to discard steam engines, boilers and chimneys entirely, and utilise all the gas in this way.

The chemical constituents of the gases produced by smelting iron ore in blast furnaces varied according to the ores and fluxes used, the fuel burnt, and the temperature of the furnaces. They contained, however, on an average, about one-third by volume of combustible gases, chiefly CO, the remainder being inert CO_2 and N. The ratio of the CO_2 to the CO varied in every furnace. The higher it was—that was the more CO_2 the gases contained—the better the efficiency of the furnace. More gas would be produced, but it had a poor heating value, and if the percentage of CO_2 was very high, the gas would not ignite in an engine. If, however, the ratio was low, and the percentage of CO high, the gas would have a relatively higher heating value. A table was given, showing the composition of the gases from six blast furnaces in England and on the Continent.

With the present methods of utilising these gases, about 10 per cent. was lost by leakage, 28 per cent. was applied to heat the air blast, 40 per cent. to the boiler, and 22 per cent. was wasted. If the latter percentage were utilised in gas engines, it would yield about 12½ horse-power hour per ton of iron melted, while if all the gases were burnt in gas engine cylinders to produce power about 28 horse-power hour per ton of pig iron would be available after deducting the power required for compressing the air. When burnt under boilers they gave a very poor heat efficiency, because the CO was of comparatively little value as fuel. At least four times as much power could be obtained when the gases were treated in an engine cylinder, the method of utilising them being more suitable. The store of power thus available had been calculated for English and Scotch furnaces at 2½ million horse-power per annum. The poorness of the gases was counteracted by diluting them with a smaller proportion of air than was required for richer gases. About one volume of air to one of blast furnace gases gave the best working mixture in an engine cylinder.

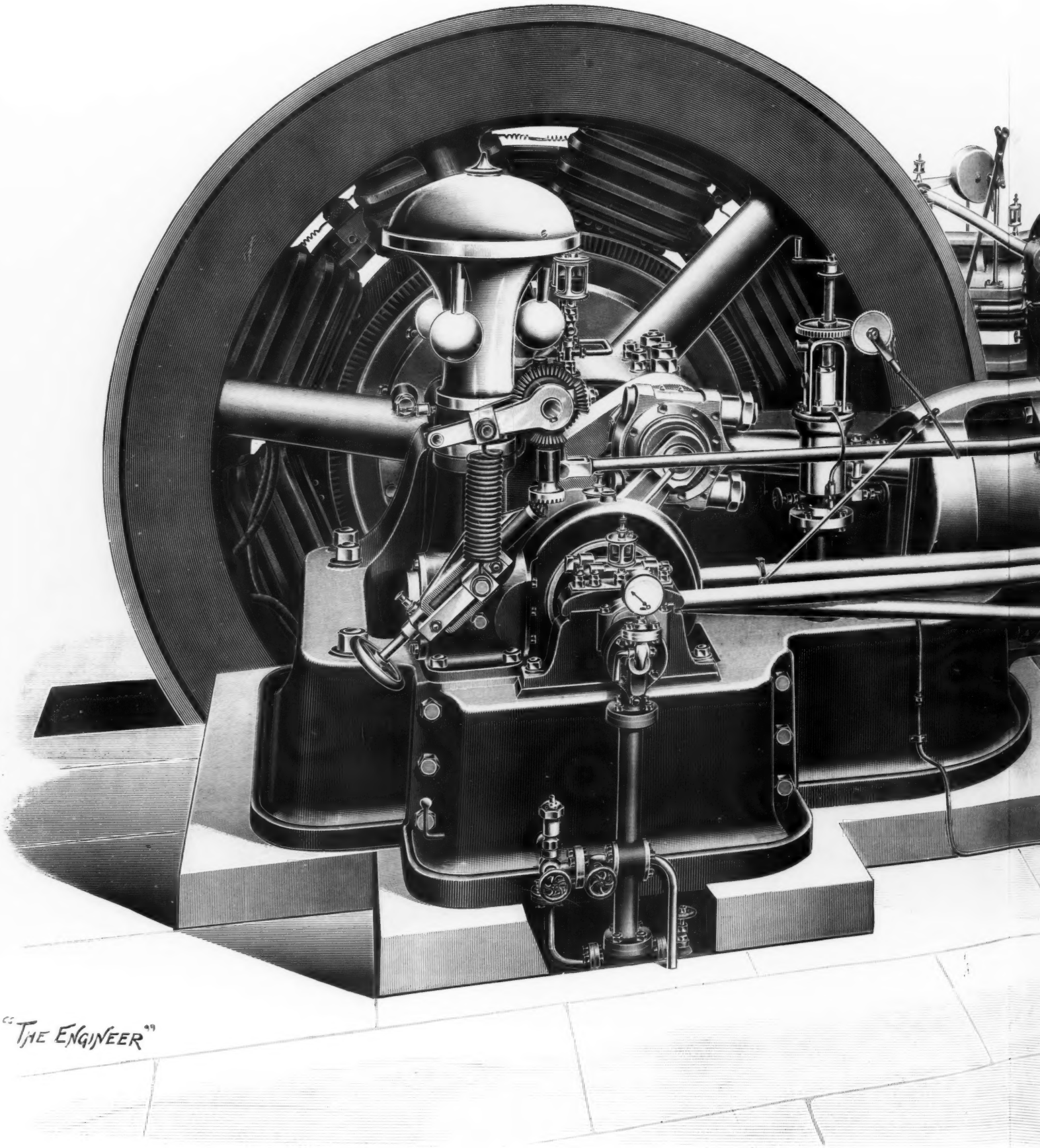
Other disadvantages were the variations in pressure and composition of these gases, their low heating value, and the dust with which they were charged. The first two difficulties were overcome by passing them into a holder before sending them to the engine cylinder, while the quantities produced were so large that these fluctuations were practically annulled. Their low heating value did not give rise to the difficulties at first anticipated, because they could be compressed to a higher degree, previous to ignition, than was permissible with other kinds of gas, when used to produce power. A high thermal efficiency was thus obtained, which compared favourably with that of other types of internal-combustion engines. Compressions of between 7½ and 11 atmospheres were used, and the lower the heating value the higher was the compression required.

The dust with which the gases were charged was of two kinds, the heavy metallic dust deposited in the long and large gas mains, and the fine light dust which was partly removed by washing and cleaning, and partly blown out with the engine exhaust. At first elaborate and costly systems of washers and purifiers had been employed, but experience had shown them in most cases to be unnecessary, and the gases were seldom subjected to any further cleaning when burnt in engine cylinders than when used under boilers; the same pipes often served both systems. Sometimes they were washed with water, sometimes they were treated by dry processes. Such light dust as remained after cleaning was forced out with the exhaust by the action of the piston, and was not allowed to be deposited and clog the cylinder and valves. Among purifiers a new form of rotary washer had so far proved one of the most satisfactory. It was said to clean the gases effectually, and took up much less space and cost less than the usual array of pipes. The methods of cleaning the gases at Seraing in Belgium, Friedenshütte, Hörde, and Donnersmarck in Germany, and Differdingen in Luxemburg, were described.

Two other difficulties were also considered, the production of gas engines large enough to utilise the vast stores of power available, and the desirability of driving the air-blowing cylinders from them direct. A great impetus had been given to the construction of large motors by the discovery that blast-furnace gases could be used to drive them. They were now made in sizes up to 1000 horse-power and 1500 horse-power, and still larger powers were in contemplation; while the difficulty of starting these large engines had been successfully overcome. To connect them direct to the blowing cylinders, which ran at a lower speed, was sometimes difficult. The subject was engaging the attention of scientific

CROSS COMPOUND TRAMW

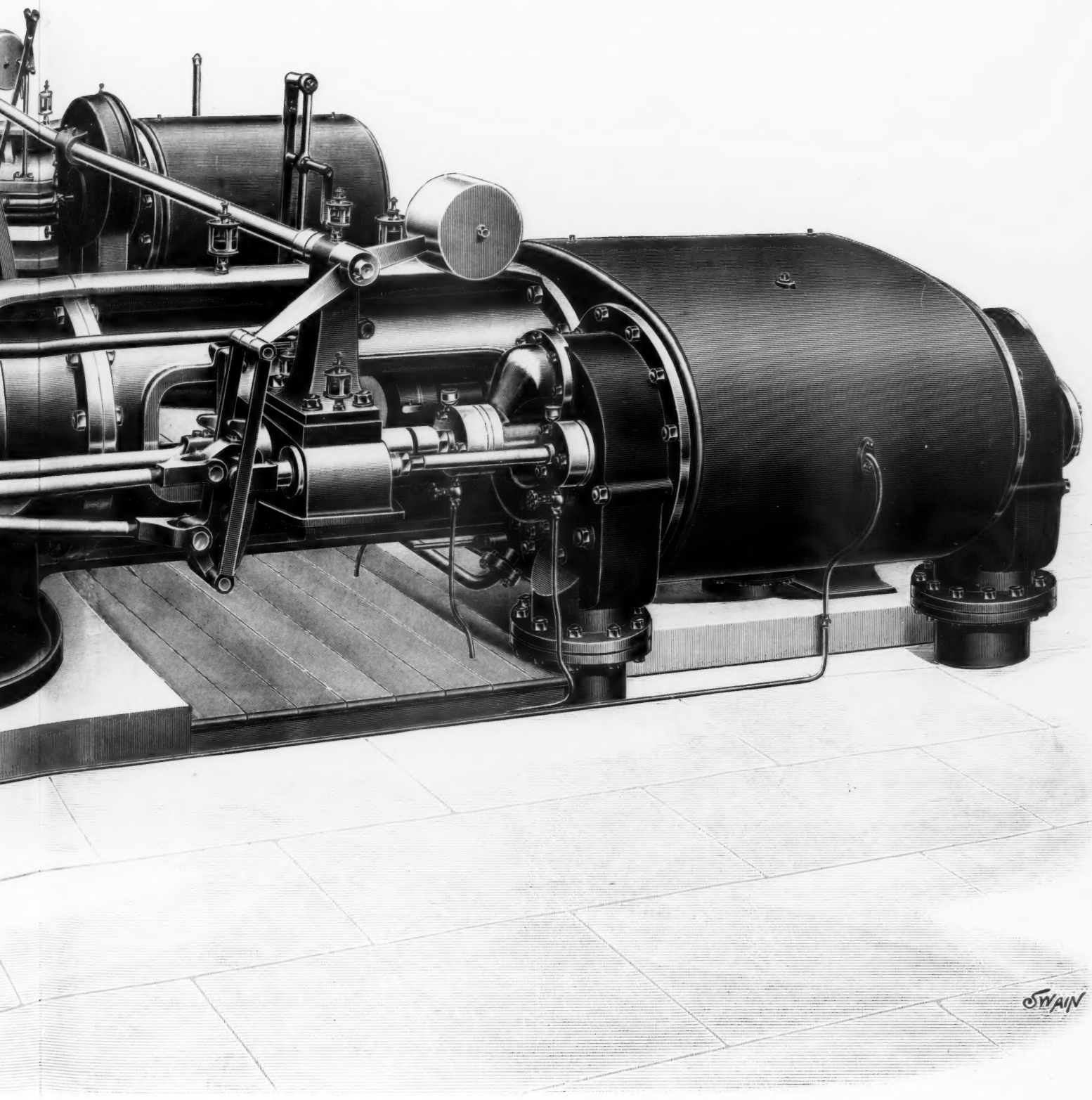
DAVEY, PAXMAN AND CO., LIMITED,



"THE ENGINEER"

RAMWAY TRACTION ENGINE

CO., LIMITED, COLCHESTER, ENGINEERS



men and engineers, and success had already been partly, and doubtless in time would be fully, attained.

A table of nine tests of blast-furnace gas engines was added; and in an addendum to the paper mention was made of what appeared at present to be the best way of getting rid of the troublesome light dust, viz., passing the gases successively through two centrifugal fans provided with water jets.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

FIRE-THROWING FROM LOCOMOTIVES.

SIR,—I am very sorry to see you intend to close this discussion, but feel I must write and endeavour to clear up some of the difficulties which your correspondents seem to think lie in the use of the fan as I suggest. I think I may say that it is almost proved that the one chief cause of fire-lifting is the jumping action produced by the blast as used at present. Take the engines in use on the Metropolitan Railway; they are worked by a jet of live steam—or the blower as it is called—and the exhaust turned into the tank, and as far as fire-lifting is concerned it ceases to exist, but the use of live steam is a remedy which is as bad as the disease. What I suggested was an attempt to substitute some contrivance which should have the same results as the jet of steam without the waste as mentioned above. Mr. A. Cotton asks, why use air and why heat it? In reply I should like to ask him, if the fan was used direct to exhaust the gases out of fire-box, how long does he think the fan would last if it were revolving in the smoke-box as he suggests. I don't think for long. It was to overcome this difficulty that I suggested to use air, as in this case the fan would be away from the action of the flames, and consequently not so likely to collapse.

Take Mr. Cotton's next question: I think there is no doubt that hot air has greater lifting power than cold, and it was for this reason I suggested hot air. He seems to think that it would entail a large percentage of levers and taps and such-like complications, but I fail to see how that could be. The draught as it is at present is regulated not by the exhaust, but by the dampers on the ash pan, and why it would not answer in connection with my theory does not appeal to me at all. Regarding low-pressure exhaust, as in the case of compound engines, I think it goes to prove my point—they being noted fire throwers—because in the majority of cases the break in the blast is more acute in a compound than in a simple engine, as you only get two coughs per revolution instead of four, and on the above class I have seen some good-sized pieces of live coal come out when on an up grade with a good load behind, which to me seems to point to no other remedy but by abolishing the exhaust entirely. I think it would not be difficult to gear the fan so as to get practically the same pressure as is produced by the exhaust; if so, it must answer as well, with the addition of preventing fire lifting. "Tyro" seems to think it would not answer in an emergency, such as when standing in the shed to raise steam quickly, but he forgets that steam is not raised in the shed by the exhaust, but by the blower or jet of live steam, and which could still remain. In connection with the above theory what I wish to make clear is that I do not advocate a fan in the smoke-box or chimney base at all, but that the fan should be outside away from the heat, and only to be the means of creating the constant stream of air to replace the exhaust, and by so doing, to obtain the same results as are derived by the present system without the waste.

J. C. WATSON.

5, Upper Belsize-terrace, Hampstead, N.W.,
December 23rd.

LARGE MINERAL WAGONS.

SIR,—It seems to be waste of time to answer Mr. Twinberrow's letter. He has not grasped the bare elements of the problem on which he claims to be an authority. His references to what he has already written, and which I have read, are quite beside the mark. I write now without much hope that he will receive enlightenment.

I want some practical information as to how I can get my coals conveyed to a seaport, a few miles away from the pits, at the cheapest possible rate. I understand Mr. Twinberrow to say that I can effect the necessary saving by doing as they do in America, and putting my coal in 30-ton or even 50-ton wagons. The only saving that I can see is the reduction in tare; the locomotive will have less non-paying load to haul. In return for this I shall have a large capital outlay on wagons, to say nothing of trouble at the staithes. But now Mr. Twinberrow tells me that the saving in tare is hardly worth considering, and that it is to be effected in some other way.

I will have nothing to do with other ways. I have to deliver my coal alongside the ship, some of it, and alongside furnaces—more of it. Can I do this more cheaply by using a 30-ton wagon than a 10-ton wagon? The wit of man cannot find how any saving is to be secured to me by using the bigger wagon, save the reduction in tare. The railway companies or the shipping people may find some other advantage; the big wagon might suit the London coal merchant better than the small one. About these things I am not competent to judge. But there is my coal, thousands of tons of it, to be moved—great part of it in my own trucks, part of it in those of the railway company. It costs me so much now. I ask Mr. Twinberrow to tell me in what way I myself personally—or, if he pleases, my company—by selling or breaking up all my existing stock of wagons, and investing several thousands of pounds in iron tubular-framed wagons of three times the size will gain. I do not want to know how the nation would be enriched. I do not care two straws whether the big wagons would increase railway dividends or not. I want Mr. Twinberrow to tell me where I would come in, and he first asks me to write to him direct, and when I refuse this he directs me to his past writings, in which I find nothing whatever to apply to my case.

The impression left on my mind is that Mr. Twinberrow cannot see, any more than I do, where I should come in.

December 23rd, 1901. COLLIERY OWNER.

VALVE GEAR.

SIR,—I have been reading the article on page 588 of your issue, December 6th, in which you gave a translation of a dissertation on valve gears delivered by Mr. Vanderstegen, and according to which it would seem that he claims for his firm the merit of having invented or produced for the first time engines with four piston valves and trip gear.

This is by far not the case, as my firm began already nine years ago to build engines with exactly the same piston valves, and has since supplied such engines for about 40,000 horse-power, among which four units of 2000 horse-power each.

At that time it seemed risky to take the double-beat valves, then used for slow speeds only, also for higher speeds as required for driving dynamos; but intrinsical improvements introduced since in the valve gear and the adoption of multiple-seat valves have allowed us to use now poppet valves for any desirable speed without any inconvenience.

If Mr. Vanderstegen has visited the Paris Exhibition, it is surprising that he speaks of hammering of the seat valves; he must entirely have overlooked the Sulzer, Tosi, and Carels engines.

It is a well-known fact that these valves, even after having worked for thirty years day and night, are just as good, if not better, than new ones, and keep constantly and perfectly steam-tight without any idea of "leakage which increases daily until it is perceived by the large consumption of steam," as Mr. Vanderstegen says.

It is further a fact as acknowledged as the above that piston valves are not and cannot be so well adapted for superheated steam as poppet valves.

My firm guarantees for a 300 horse-power compound engine with moderate superheating a steam consumption of 4·4 kilos. per indicated horse-power an hour. Mr. Vanderstegen would most likely meet with surprises with such guarantees for piston valve engines.

(Pro FRANCO TOSI)
Legnano, December 20th. G. BONER.

WATER-TUBE LOCOMOTIVE BOILERS.

SIR,—You illustrate on page 603 of the current issue a water-tube locomotive boiler, designed by Mr. D. Drummond, M.I.C.E., for the London and South-Western Railway.

It may interest your readers to know that a water-tube boiler having cross tubes in a cylindrical flue, as shown in your illustration, was patented in 1870 by the late Mr. Isaac Watt Boulton, who was probably the first to build a locomotive having a water-tube boiler. In Mr. Boulton's boiler the ordinary square locomotive fire-box was dispensed with, and the cylindrical flue was attached to the shell with faced joints and bolts at each end, so that the flue could easily be withdrawn for re-tubing. Several locomotives with cylinders 12in. by 18in. were built at Mr. Boulton's works having this type of boiler, and were very rapid steamers. One of these was used by the late Mr. Charles Sacré, locomotive superintendent Manchester, Sheffield, and Lincolnshire Railway, at London-road Station, Manchester, for shunting; they were also used at the Marquis of Bute Docks, C. Cammell and Co.'s works, Whitland and Taff Vale Railway, &c. A locomotive was also built at the London and North-Western Crewe Works, having a cross-tube boiler, but in this case the flue was square, with its diagonals vertical and horizontal respectively. Portable and semi-portable engines were built with cross-tube boilers by the late Mr. Boulton, and a 28 horse-power semi-portable, with Mr. Boulton's patent boiler, was fully illustrated in THE ENGINEER for 1875, page 261.

Wembley, December 18th. HAROLD W. BOULTON.

HERACLEE COAL.

MESSIEURS,—Nous lisons, dans votre numéro du 13 courant, une note sur les résultats obtenus par l'Amirauté Anglaise dans l'essai de charbons du bassin d'Héraclée. Nous attirons votre attention sur le fait qu'il y a plusieurs exploitations de charbons dans le bassin d'Héraclée. Les conclusions de l'Amirauté, signalées par vous, ne peuvent s'appliquer aux charbons de notre Société, qui seule dans ce bassin procède à un criblage soigné, et à un triage à la main ou à un lavage mécanique de ses charbons. Les qualités livrées au commerce ne donnent pas plus de 7 à 9 % de cendres. Nos expéditions se font de notre Port de Zongouldak où de nombreux navires Européens viennent charbonner régulièrement et où nous avons installé des lavoirs, fours à coke, Usine à Briquettes et moyens mécaniques de chargement.

Au surplus, nos charbons n'ont jamais été soumis à l'examen de l'Amirauté Anglaise, dont les essais doivent se rapporter aux produits de petites exploitations d'affleurement.

Nous attendons de votre courtoisie et de votre impartialité l'insertion de cette lettre, et nous vous prions d'agréer, Messieurs, l'assurance de notre considération très distinguée.

C. A. NAVILLE, l'Administrateur Délégué.
Société d'Héraclée, 21, rue de Londres,
Paris, December 18th.

INSANITARY ANGLES.

SIR,—I have read Mr. Mark H. Judge's letter in your specially valuable issue of 13th inst., and sympathise with him. I would respectfully draw his attention to my letter in your issue of May 25th, 1900, page 545—vol. lxxxix., No. 2317. I had recently a similar case at Pembridge-gardens, where I was anxious not to interfere unduly with the ground adjacent to and at lower level than the foundations of two high buildings. The drain had a regular fall throughout, and as the following brief description may be suggestive, I beg your space. I carefully excavated holes, planked and strutted and tunnelled under, and then threaded the pipes through, which were heavy cast iron coated with Dr. Angus Smith's solution caulked with blue lead. Before doing this work, I carefully affixed plaster strips across the several slight cracks and noted the directions thereof, and I am glad to say after fifteen months no trace of further settlement can be found. I should like to see the subject of house drainage thoroughly treated in your practical journal. A. EDMUND PARNACOTT.

"Gernsbach," Penge, S.E., December 23rd.

ON RECENT PRACTICE IN LOCOMOTIVE ENGINEERING IN ENGLAND AND IN OTHER COUNTRIES.

SIR,—On reading the letter *re* above in your issue of the 13th inst., I note where it states the increase of engine power in recent years, giving particulars of some of the latest engines, that the express engines for the South-Eastern and Chatham Railway—designed by Mr. Wainwright—the heating surface and grate area given is practically correct, but the adhesive weight is incorrectly given as 27½ tons. This should be 33 tons, which is a considerable difference. I would call your correspondent's attention to the general drawing and principal particulars of these engines published in your issue of July 19th, 1901, where he will find the heating surface, grate area, and adhesive weight correctly given.

December 19th, 1901. ROCKET.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Compressed air riveting.—For repairing and strengthening bridges on one of the divisions of the Baltimore and Ohio Railroad there is a portable compressed air plant, which is placed on a siding near the bridge and connected up to a 1in. pipe line, having valves and connections for flexible hose to the pneumatic tools. The plant, all mounted on a 35ft. railway wagon, consists of an air compressor with a capacity of 95ft. of free air per minute, a 25 horse-power boiler, an air receiver of 150 lb. capacity, and a water tank holding 300 gallons. This air is used to operate a drill fixed on the wagon, riveting hammers, a yoke riveter, chipping hammer, and rivet forges. Wire-bound india-rubber hose is used for the flexible connections. Some similar plants have gas or gasoline engines. In any case a small portable pump is used, being set on the bank of the stream to pump water through a 1in. pipe to the water tank and to the water jackets of the air compressor cylinders and gas engine cylinders. The plant is sometimes operated half a mile from a bridge. The cost of such a plant complete is about £320. Two men can drill five to six holes with the air drill in the same time it would take them to drill one by hand, while in riveting, two men with the air hammer will do as much work as three men with hand tools. One advantage is that any intelligent helper can soon learn the use of the pneumatic hammer, while for hand work skilled riveters are required. With rivets up to ⅞in. diameter the method is both effectual and economical. The foreman must look out for loose rivets, whether hand or air hammers are employed. The foreman can usually see to the firing of the boilers and the running of the compressor, and can assist at all work that is done at the drill on the car. About a quarter of a ton of coal is used per day.

Marine notes.—In addition to continued activity in new construction, several of the American shipyards are carrying out improvements and alterations to old steamers. The Clyde Line has had two of its coasting steamers, the Comanche and Iroquois, lengthened 48ft. The Iroquois was built in 1888, and was 280ft. long, 46ft. beam, and 28½ft. deep, 2944 tonnage gross. It will now carry 2000 more bales of cotton. The work on this vessel was all done in 21 days. The Oceanic Steamship Company, operating in the Pacific, has had the Alameda, built in 1883, fitted with new engines. She originally had compound engines of 2500 horse-power, giving an average speed of 13¾ knots on 65 tons of coal per day. She now has triple-expansion engines of 3000 horse-power, with cylinders 29in., 47in., and 78in. diameter and 58in. stroke. Steam is furnished by three Scotch boilers, carrying 180 lb. pressure. This equipment will give an average speed of 15 knots on 56 tons of coal per day, and will increase the dead-weight carrying capacity by 1000 tons. The Ward Line is having its New York and Cuba mail steamer Niagara fitted with new boilers, the old ones having been in use for twenty-four years, or since the vessel was built in 1877. A slipway of 3000 tons capacity, with quadruple chain hauling gear, has been built for ship repair work at San Francisco. It can take vessels up to 300ft. long and 74ft. wide. A new car-ferry steamer, to carry trains across Lake Michigan, is to be built for the Clun Arbor Railway. It will be similar to other vessels now in service, but with engines of 5000 horse-power. She will cost £60,000. The Mallory Line will soon put in service between New York and Galveston the new steamer Denver, 368ft. long, 48ft. beam, 35ft. deep, 3000 tons dead-weight capacity, 1260 tons bunker capacity, 250,000 cubic feet of cargo space. She will be driven at 15½ knots by a triple-expansion engine with cylinders 33in., 54in., and 87in. diameter and 54in. stroke. A new Lake cargo steamer recently altered will have quadruple-expansion engines, with cylinders 19in., 27½in., 40in., and 58in. diameter and 40in. stroke. This steamer will be 345ft. long, 44ft. beam, and 28ft. deep. Her Scotch boilers will carry 210 lb. pressure. Many of the large Lake steamers now have engines of this type. The Cramps' shipyard will soon be ready to launch the Finland and Kroonland for the New York, Southampton, and Antwerp service of the American Line. They will be 580ft. long, 70ft. beam, and 30ft. deep; of 12,000 tons gross register.

The Atchison, Topeka, and Santa Fe Railway.—One of the largest of the railway systems of the United States is that of the Atchison, Topeka, and Santa Fe Railway, extending from Chicago, on Lake Michigan, to San Francisco, on the Pacific Ocean, and Galveston on the Gulf of Mexico. This system comprises 7810 miles of railway. For the year ending with June, 1901, the gross earnings were nearly £11,000,000, with working expenses £6,900,000, or 59·23 per cent. of the earnings. Many new and powerful locomotives were substituted for older and lighter engines, and several engines were converted to the use of oil fuel at a cost of £60 per engine. The maintenance of way and structures averaged £165 per mile, and the total working expenses £826 per mile. Gradients are being reduced to a maximum of 1 in 250, except in the mountain divisions. At San Francisco new terminals are being established by reclaiming fifty-two acres of land, and the improvements here will cost £150,000. The rolling equipment includes 1174 locomotives, 717 carriages, 29,229 goods wagons, and 739 wagons, &c., in railway service. The following figures are of interest:—

Miles run by passenger engines	11,948,059
" " goods engines	21,077,424
" " shunting engines	4,311,333
" " on mixed trains	1,644,473
" " by work engines	814,954
Total miles run by engines	39,796,243
Cost per mile run of engines, fuel	5·11d.
Oil and waste	0·15d.
Miscellaneous supplies	0·11d.
Wages	4·24d.
Engine repairs	4·10d.
Total	13·71d.
Miles run per ton of coal	18·48
" " pint of oil	10·92
" " lubricating oil	16·32
Coal, cost per ton	7s. 9d.
Wood, cost per cord	7s. 2d.
Passengers carried	5,664,811
Passenger earnings	£2,335,603
Passenger-miles, passengers carried one mile	514,037,047
Goods carried	11,112,614 tons
Goods earnings	£7,810,512
Goods-miles, tons carried one mile	38,769,793,344

Electric tramways power plant.—The electric tramways system of St. Louis, U.S.A., has about 450 miles of line, all operated from two main power-houses, and one sub-station or transformer house. The main station has engines of 23,500 horse-power, capable of developing a maximum of 36,000 horse-power. There are four cross-compound engines of 3400 horse-power each, directly connected to four generators of 2250 kilowatts capacity; three cross-compound engines of 2300 horse-power directly connected to as many generators of 1500 kilowatts, and three tandem compound engines of 1000 horse-power directly connected to three generators of 650 kilowatts capacity. Steam is supplied by thirty water-tube boilers, sixteen being O'Brien boilers with straight tubes slightly inclined, and fourteen being Sterling boilers with vertical tubes. All have chain grate automatic stokers, coal being delivered to the fires by an endless conveyor from a storage house of 3500 tons capacity. There are fifteen feed-water purifiers and seven heaters. All the hot and cold water is measured by Worthington piston meters and Hersey disc meters. The sixteen boilers have one steel chimney 200ft. high and 14ft. diameter. The fourteen have four 6ft. chimneys 160ft. high. There are two 36in. and 48in. jet condensers, and the condensing water is cooled in twelve cooling towers with fans. The smaller station has seven engines, developing 14,000 horse-power normal, or 21,000 horse-power maximum. There are two cross-compound engines of 3400 horse-power with two 2250-kilowatts generators; two cross-compound engines of 1800 horse-power with two alternators of 1200 kilowatts and three engines of 1200 horse-power with three generators of 800 kilowatts. All these units are direct connected. Steam is supplied by 16 O'Brien water-tube boilers, with chain grates, and there are eight purifiers, four feed-water heaters, and four boiler feed pumps. Surface condensers are used, and the condensing water is cooled in towers supported above the roof, the air currents through the towers being forced by fans driven by electric motors. There is a complete system for weighing the coal, measuring the water, and handling the coal and ashes.

Paper and pulp works in the United States.—The United States census bulletin on the paper and paper pulp industry shows that this has attained to great importance within recent years, and paper pulp is largely exported. A large proportion of the spruce timber used for wood pulp comes from Canada, but 598,229 cords of domestic spruce were used, valued at £571,175. Out of 763 pulp works, only 134 used domestic spruce for ground pulp, while 46 used it for sulphite pulp. The report shows that there are 763 pulp and paper-making establishments, with a combined capital of £33,501,540, paying £900,200 per year to 2935 salaried employés, and £4,150,000 per year in wages to 49,646 employés. Of these employés, 41,547 were men, 7930 were women, and 169 were children under sixteen years. The value of the materials used was £14,106,000; this included about 2,000,000 cords of domestic and Canadian spruce and poplar, 234,514 tons of rags, 356,193 tons of old paper, 99,301 tons of rope, thread, bagging, &c., and 367,305 tons of straw. Besides this, there were 644,006 tons of ground and chemical wood fibre pulp purchased ready-made. The total product was 3,342,156 tons, valued at £25,460,000, for the year 1900. The average value was £7 per ton for newspaper, £14 per ton for book paper, and £9 per ton for wrapping paper. The paper machinery included 663 Fourdrinier machines, with a total width of 56,436in.; 569 cylinder machines, 38,860in.; and 1049 wet machines. Also 3739 beating engines, 900 washing engines, and 1167 Jordan or refining engines. The mills making sulphite and soda fibre pulp had 426 digesters of 3813 tons capacity, and 307 boilers of 45,510 horse-power, making 4926 "cooks" per week. The mills making ground wood pulp had 1168 grinding machines. The mills aggregated 764,847 horse-power, and had an annual capacity of 2,782,219 tons of paper and 1,536,431 tons of pulp.

Gas engines.—The pumping machinery for the fountains of the

electric tower at the Pan-American Exhibition at Buffalo, U.S.A., was driven by a Nash gas engine of 125 horse-power. These engines are of the four-cycle, vertical, inverted, enclosed, self-oiling type, with one, two, or three cylinders, according to the power of the engine. All the cylinders are identical in construction, independent of each other, and mounted on the casing which encloses the connecting-rods, &c., the lower part of the chamber forming an oil bath. The cylinders are water-jacketed on the sides, heads, and valve cases, and the single-acting trunk pistons act as crossheads. The crank shaft is cut from a solid blank of forged open-hearth steel, and runs in adjustable bronze boxes, each crank having a bearing on each side. A single cam shaft, driven by a pair of spur gears, operates all the valves through a system of levers and rollers. Each cylinder has its gas valve, admission valve, and exhaust valve. Speed is regulated by missing ignition when the normal speed is exceeded, the governor then closing the gas valve. When a charge is missed the admission valve still permits air to enter, which, being compressed, expanded, and exhausted, cleans the cylinder. The valves are of drop-forged steel, with guides and long stems to secure accurate seating. The valves are usually ground soon after the engine has been put at work, and may then run without any attention for a year or more. Electric igniters are used, and the fly-ball governor is driven by bevel gearing from the cam shaft. The 125 horse-power engine has three cylinders, 13½in. diameter and 16in. stroke, and the normal speed is 225 revolutions per minute. For starting compressed air from a reservoir is used in one cylinder. As soon as speed is attained, and the other cylinders are working gas, the starting lever is thrown over and the air mechanism disconnected, when the cylinder at once begins to work again as a gas engine.

A large central boiler plant.—As the result of a consolidation of electric light and electric tramway companies at Baltimore, U.S.A., the power-generating plants now installed in a dozen different stations are to be concentrated in one large central station. The first step has been to provide the boiler plant for this station. The new boiler-house is on the water front, and is a steel skeleton building with brick walls and a slate roof. It is 94ft. by 130ft. in plan. There will eventually be a boiler capacity of 16,000 horse-power, and there are now boilers of 4000 horse-power already installed. The boilers are of the Babcock and Wilcox water-tube type, of 500 horse-power each, and are arranged in batteries of two. There will be four batteries on each side, making eight on each floor. The chimneys are in the centre line of the building, each connected with four batteries, two on the lower and two on the upper boiler-room floor, or 4000 horse-power to each chimney. Each boiler has 216 tubes, 4in. diameter and 18ft. long, laid twelve high and eighteen wide, with two 42in. drums, 22ft. long. The Roney automatic stokers are used, driven by eight Westinghouse engines of 6 horse-power. Special drip pans, with water, are placed to catch the fine coal which sifts through the stokers and is usually wasted with the ashes. There will be eight vertical compound feed pumps, two to each 4000 horse-power, the plant being in duplicate. The feed-water from the city mains passes round the engine bearings, and then through two sets of heaters heated by the exhaust from the main and auxiliary engines. It is delivered to the boilers at 208 deg. The steel chimneys are 200ft. high and 13½ft. inside diameter, and are lined with brick. Coal from railway wagons or ships is unloaded by two coal-handling plants with a capacity of 50 tons per hour each. The boom for hoisting is 52ft. long, and the hoists are operated by electric motors. The buckets carry one ton of coal each, and deposit the coal—which is first crushed to size—in two rows of bins above the boilers. The ashes fall by gravity into a conveyor, which delivers them into an elevated tank or bin, from which they are loaded by gravity into carts or ships.

The American Exhibition of 1903.—To celebrate the "Louisiana Purchase," by which in 1803 the United States purchased from France the great territory extending from the Gulf of Mexico to the British possessions, then styled Louisiana, an International Exhibition is to be held at St. Louis, U.S.A., in 1903. The preliminaries are well in hand, large resources are available—including liberal grants from the Government, and work has been commenced. The site will be mainly the west half of Forest Park, reached by electric tramways and a local belt railway, and the site includes two plateaus separated by a slope, the maximum difference in elevation being 60ft. The lower plateau has an area of some 400 acres, and here will be the main buildings, the lakes, and the principal constructive and decorative features of the Exhibition. The main avenues will be 300ft. wide, radiating from a central court in the form of a fan, and the principal entrance will have a monumental gateway with towers 400ft. high. The principal buildings are as follows, all designed by different architects, but conforming to a general scheme prepared by the Board of Architects, and each design was submitted to the criticism of all the other architects before acceptance, so as to ensure harmony in the general effect:—Art building, 300ft. by 900ft., with two pavilions each 200ft. square; Agricultural Building, 700ft. by 2000ft., the largest structure in the country; Manufactures Building, 600ft. by 1200ft.; Liberal Arts Building, 600ft. by 550ft.; Electricity Building, 600ft. by 550ft.; Mines and Metallurgy Building, 600ft. by 1200ft.; Transportation Building, 600ft. by 1300ft.; Government Building, 400ft. by 250ft., with separate pavilions for Fisheries and Ordnance; Social Economy Building, 550ft. by 750ft.; Education Building, 550ft. by 750ft. The buildings will be mainly of timber construction, clothed with the now familiar "staff" plaster. This is partly on account of the less liability to delays incident to strikes or other troubles with the steel mills.

Coal mining machinery.—The use of coal-cutting machinery in the bituminous coal mines of the United States is steadily increasing, and a number of different styles of machines are in use, most of them being operated by electricity. The Morgan and Gardner machine has a frame 10ft. long and 24in. wide, on which runs a truck or trolley, carrying the chain-driving gear and motor, the chain being carried by a supplementary frame, which is fed forward by a gear operated by the same motor and engaging with a rack on the main frame. The total height is only 2½ft. The width over the cutter head is 42in., and 45in. over the bits. The weight is about 2400 lb., and the machine will cut to the full stroke of 6ft. in 3½ to 4½ minutes, according to the character of the coal, backing out again in 30 to 45 seconds. The chain is made up of malleable cast iron links, fitted with forty-eight straight bits, and the speed of travel of the chain is 275ft. per minute. The number of gear wheels is reduced to a minimum, the armature having a vertical shaft with a pinion engaging directly with the chain drive wheel. A worm gear operates the feed. The motor is of the multipolar type, with internal fields. The armature makes 750 revolutions per minute, with a current of 220 volts at the machine, or 500 volts for large machines in heavy work. For transportation from place to place the machine is carried on an ordinary mine truck. In the shearing machine the chain belt works in a vertical plane, between top and bottom frames, the armature in this case having a horizontal shaft. The Morgan-Gardner electric locomotives, of five to twenty-five tons weight, have heavy cast iron frames and two axles, each driven by its own motor. The wheels are not coupled, but when pulling loads the motors are run in parallel, driving both axles. When running light only one motor is used.

Boiler problems.—At a meeting of the New England Cotton Manufacturers' Association, U.S.A., a paper on modern boiler problems was read by Mr. E. D. Meier. He advocated abolishing the rating of boilers by horse-power, and rating them instead by the units of evaporation—or the number of pounds of water evaporated from and at 212 deg.—which the boiler is to furnish as its normal work, with the one-third margin recommended by the American Society of Mechanical Engineers. "The greatest possible heating surface is not the only consideration, but circulation of gases and water is of great importance, especially in water-tube boilers, and in many cases the steaming capacity has been improved by the removal of an entire row of tubes from a horizontal water-tube boiler, the increased circulation more than compensating for the decrease in heating surface. The ratio of heating surface to grate surface must be variable according to fuel and draught, grate and draught enough being provided to burn a sufficient quantity of the particular coal to be used. The best bituminous coal will give 10½ units of evaporation per pound, and we burn 24 lb. per square foot of grate; anthracite egg coal, 9½ units and 20 lb.; pea coal, 8½ units and 18½ lb.; buckwheat coal, 7½ units and 16½ lb.; rice coal, 7 units and 15 lb. Putting these together, and taking the old horse-power rating, we find that we can count on 7·1 horse-power per square foot of grate for best bituminous coal, 5·8 horse-power for egg, 4·4 horse-power for pea, 3·6 horse-power for buckwheat, and 3 horse-power for rice coal. As there is a practical limit to the length of grate which a fireman can manage, the width of furnace becomes the important point, and in placing the proper amount of heating surface over it we come to a low broad boiler for low-grade anthracite, and a high narrow boiler for high-grade bituminous coals. Automatic stokers can handle grates 2ft. or 3ft. longer than can be operated with hand, and accomplish a combustion of 22 lb. They present the possibility of permanent adoption of the cheaper fuels without increase or complete change in the boiler plant."

A new oil gas.—Gas is now very largely used, not only for lighting, but for manufacturing processes—especially forging and welding, and also for domestic and laboratory purposes. In view of the advantages, endeavours have been made to produce a gas cheap enough for use in regions where natural gas is not obtainable. The Acme gas now being introduced in the United States is intended for use in towns, factories, and dwellings, the process making a fuel and illuminating gas at a cost of 6d. to 7½d. per 1000 cubic feet. The gas is made from petroleum, two gallons being sufficient to make 1000 cubic feet. It is of high calorific efficiency, and gives a soft penetrating light. The special feature of its manufacture is the converting of petroleum into a fixed gas by forcing air at 3 lb. pressure by a blower through the oil and through perforated diaphragms and a porous material. This process is continued through a series of generators, the number depending upon the volume required. No residuum is left in the generators. The apparatus works automatically, and the production of gas varies automatically with the number of burners lighted. The gas is a light, free gas, with no unassimilated hydrocarbons. It is being used for street lighting, and shows advantages over gasoline and coal gas in operating gas engines. It is also being extensively used for tempering, welding, and forging metals, and for smelting. In the United States navy yards it is used for making gun forgings, and in some of the large factories for agricultural machinery it is used for welding up iron wheels.

Electric tramway operation.—The question as to the respective merits of direct-current and alternating-current motors for electric traction, which has been recently under discussion in regard to the London underground railways, has also been discussed by American engineers. The consensus of opinion, however, is that the field for the alternating-current motor is limited strictly to maintain lines or to long-distance railways with very few stops. Not only is it less efficient on the whole, but it is ill-adapted to the varying speeds and variable power which are characteristic of railway work; while it requires greater care in its maintenance and repairs. Under the present system, electric railways of large extent usually have alternating current generated at the central station and stepped up by transformers to high tension. It is then sent out to substations along the line, where it is stepped down to lower potential, and then used in rotary converters which deliver the direct current at low potential to the overhead wire or the third-rail conductor. If alternating-current motors were used on the cars the converters could be dispensed with, but when a balance is struck between the advantages of this current for distribution and its disadvantages for motors, it does not appear able to compete with the direct current in any ordinary electric system. The only apparent chance for its introduction in railway service is for lines with very light gradients or uniformly ascending gradients, or railways on which the trains make long runs with few stops. As to fuel economy as compared with steam locomotives, an analysis shows that with the numerous losses in transmission, conversion, &c., the final efficiency at the car wheel would be only 50 per cent. of that at the engine cylinder, which is about the same as a well-designed steam locomotive. The first cost, however, for electric plant would be equivalent to £17,000 per electric locomotive, or ten times that of a steam locomotive for the same service.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

UPON the week there is little alteration of consequence in the state of trade. Quotations keep at £8 10s. for marked bars, and £9 2s. 6d. for Earl Dudley's brand. Second grade bars are £7 10s.; common unmarked bars, £6 10s. to £6 15s.; and North Staffordshire bars, £6 15s. to £7 per ton. Angles are £6 15s. to £7; hoops, £7 10s.; gas tube strip iron, £6 15s.; and rivet iron, £7 5s per ton.

Steel is active at the local works, notwithstanding all the German competition. But the explanation is that the Staffordshire works do not lay themselves out for the tin bar and billet trade, and never did; hence the foreign importations do not much trouble them. Bessemer billets are quoted £4 15s. to £5; Siemens ditto, £5 to £5 5s.; mild steel bars—locally made—£6 15s. to £7 5s.; plates—the stronghold of the Staffordshire works—£7 to £7 10s. for superior sorts; girders, £6 to £6 5s.; and angles, £6 to £6 5s. also.

A review of the pig iron market during the past year shows that at the January quarterly meeting the market favoured buyers, and notwithstanding the extraordinary dearness of fuel, pig iron prices were weak. Among consumers the belief existed that prices would decline as the year advanced, and they withheld orders. Producers, however, declared that prices were wholly unlikely to go lower, considering the high costs attending pig iron production, and they urged that buyers would early realise this position. Rates were as follows:—Staffordshire cinder forge, 57s. 6d. to 60s.; part-mine, 60s. to 65s.; serviceable all-mine, 62s. 6d. to 75s.; superior, 90s. to 95s.; foundry, 100s.; and cold blast, 120s.; Northamptons, 52s. 6d. to 55s.; Derbyshires, 53s. 6d. to 57s. 6d. Most of these quotations were 15s. to 20s. less than was being asked at the October quarterly meetings of 1900, a circumstance alone which will sufficiently show that the year opened with a period of depression. Blast furnaces were being blown out here and there owing to the high price of coal and cokes, and the number of furnaces in the South Staffordshire and the East Worcestershire districts in blast was reduced to eighteen out of a total erected of fifty.

At the April quarterly meetings pig iron deliveries, owing to the blowing out of furnaces, were much limited, and in consequence prices were well upheld at 46s. to 48s. for Staffordshire cinder forge qualities; 48s. to 50s. for part-mines; medium, 52s. 6d. to 60s.; and best all-mine hot-air, 85s. Derbyshire forge pig iron was 43s. 6d. to 50s., and Lincolns 51s. In May there was a distinct improvement in trade, accompanied by a great willingness of consumers to operate, and Northampton forge pigs rose to 47s. and 49s., and Derbyshire 49s. to 51s. June showed a further strengthening of demand, and prices rose 1s. to 1s. 6d. per ton, Lincolnshire pigs being quoted 50s. 7d. at stations, and North Staffordshire forge pigs 49s. 6d. to 50s. 6d. At the July quarterly meeting supplies were still short, and prices of Northampton forge pigs were well upheld at 47s. to 48s. 6d., Derbyshires 48s. 6d. to 50s., and Lincolns in proportion. Staffordshire cinder pigs were quoted 45s. to 46s.; part-mine, 49s. to 52s. 6d.; all-mine, 52s. 6d. and upwards to 60s.; best ditto, 75s.; cold-blast, 95s. to 105s. The limited output and bareness of stock kept up prices throughout August, when there was almost a famine in respect of deliveries, and foundry iron, in particular, rose 2s. 6d. per ton, Northampton foundry pigs being quoted 56s., and Derbyshires 58s., with the prospect of further advance.

Lincolnshire pigs early in September touched 55s. 7d. per ton delivered Staffordshire for No. 3 iron, and 52s. 7d. for No. 4, but in the boom period of eighteen months to two years before the same iron reached the great height of 80s. to 81s. per ton. The number of furnaces blowing in the Staffordshire and Midland districts combined during September was returned at 91 out of a total of 180 erected. At the closing quarterly meeting of the year—October—makers had entire control of the pig iron market, and sellers had to give just what was asked.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Holiday stoppages, stock-takings, and other special conditions peculiar to the season are just now more or less interfering with industrial operations. Generally, however, and apart from circumstances that are temporary, the engineering trades of this district are scarcely closing the year with very satisfactory surroundings, and the prospects for the ensuing year are certainly not of the most promising character. Outside electrical engineering and the special branches to which it is closely allied, and the locomotive building trades, the general report is that new orders are not by any means plentiful, and there are anticipations of a quiet time next year, with the probability of a considerable number of workmen thrown out of employment.

The past twelve months has, however, not been an unsatisfactory period for the general engineering trades of Lancashire, although the situation has varied considerably in different sections of industry. As already intimated all branches of electrical engineering have been fully engaged. The greatest pressure has been in connection with traction work, municipalities having apparently allowed new lighting installations to remain somewhat in abeyance, preferring to push forward the numerous developments of electric tramway systems that are now in progress in different districts. This activity in electrical engineering has also had its effect upon allied branches of industry, such as the building of high-speed engines suitable for dynamo driving, and most of the Lancashire firms who make engines of this type have been very full of orders all through the year. There is, perhaps, not quite so large a weight of work in prospect for the ensuing year, but more than sufficient to keep most of the electrical engineering and high-speed engine-building firms well engaged for a considerable time ahead.

In the other branches of industry already referred to—locomotive and railway carriage and wagon building—which have been exceptionally brisk, most of the Lancashire firms have orders on their books that will carry them well through the next twelve months, but here also the new business offering is not so pressing as it has been of late. During the past twelve months locomotive builders in this district have been compelled to allow a good deal of work to pass by them, owing to their inability to entertain further engagements for anything like early delivery; but it is unlikely that any further important orders, such as the one for the Indian Railways, secured by German locomotive builders, will be allowed to pass into foreign hands.

Business in the boiler-making trade has fluctuated, but the principal firms have had not at all a bad year. Makers of gas engines have been full of orders, and one feature in this department is their adaptation to higher powers, and the utilisation of waste furnace and other cheap gases. The much lower prices of iron and steel have also had the effect of bringing forward a good deal of heavy structural work that was temporarily suspended during the boom of high-priced materials, and firms engaged on this class of engineering have generally been fairly well employed.

In some other branches, however, the results of the year's operations are scarcely so favourable. Amongst machine tool makers, although actual slackness has not been at all general, the weight of new work coming forward has steadily fallen off, orders running out more rapidly than they were being replaced, not only dispensing with overtime, which had previously been prevalent, but in some instances rendering it difficult to keep shops even ordinarily engaged, and necessitating a considerable reduction in the number of men employed. Textile machine makers have passed through a period of exceptional depression, from which there has been no indication of any early recovery, and builders of the heavier types of engines for mill driving have been only indifferently supplied with orders.

Shipbuilding on the Mersey of any importance is confined to the operations of Laird Bros., Limited, of Birkenhead, and during the past twelve months they have launched the following vessels:—H.M.S. Exmouth, steel twin-screw, 14,000 gross tons register—displacement not measured—fitted with triple-expansion engines, 18,000 indicated horse-power, with a speed of 19 knots; two torpedo boat destroyers for foreign Governments, of 321 gross tons register, with triple-expansion engines, 6250 horse-power, and a speed of 30 knots; and a twin-screw steamer for the British Government, of 1400 gross tons register, with triple engines, 3250 indicated horse-power, and a speed of 16 knots. The machinery of H.M.S. Implacable—15,000 horse-power—has been completed at Devonport Dockyard, and the vessel has carried out her trials and been commissioned. The machinery of H.M.S. Montagu—18,000 horse-power—is now being erected on board at Devonport. New water-tube boilers for H.M.S. Blonde have been delivered at Devonport Dockyard.

An incident during the past year which has created a good deal of discussion has been the placing out by the Manchester Corporation of a very large contract for electrical plant with the German Electrical Company, Limited. This has given rise to some heated discussion both in the Council and the local Press generally, and but for the fact that electrical engineers in the district are so heavily pressed with other work, the matter would, no doubt, have come in for even stronger criticism. I have previously given the particulars of this contract in my Lancashire notes, and need only mention here that the plant required was two 6000 horse-power engines and three-phase generators and motor generators, and the tender of the German firm amounted to £113,000, which was £36,000 under the lowest purely English tender. Another corporation contract indirectly connected with engineering, which has also been successfully competed for by a foreign firm, was one for 650 tons of steel rails, which a Belgian concern has contracted to supply to the Salford Corporation at £6 per ton, or £1 less than the lowest English quotation.

The important developments of engineering enterprise that have been going on in this district since the settlement of the great strike have during the past year been pushed forward with unabated vigour. The most notable is that in the neighbourhood of the Manchester Ship Canal, at Trafford Park, which is rapidly becoming one of the leading engineering centres in England. The extensive works of the British Westinghouse Company are getting very near to completion, whilst other smaller but still important establishments have either been completed or their erection commenced. Another important addition to the engineering industries of the district is the large works of Sir W. G. Armstrong, Whitworth and Co., Limited, at Openshaw, for the manufacture of armour plates, where Government orders have already been secured. In other directions also the erection of new or extension of existing engineering works has been going on, and amongst these I may mention the new works of Craven Brothers, Limited, at Reddish, and Royles, Limited, at Islam, near the Ship Canal, together with large additions to the works of Crossley Brothers, Limited; Galloways, Limited; Hulse and Co., Limited; and Joseph Adamson and Co.

The workmen have little ground for complaint as to the state of

employment during the past year. There has, perhaps, been considerably less overtime; but for the greater portion of the past twelve months the percentage of unemployed members on the books of the trade unions has remained comparatively low. Towards the close the number has substantially increased, and in the textile machine trades the proportion of unemployed is heavy. Steady employment has, however, been the rule, and the trade union societies will commence the new year with a continued improvement both in their financial and numerical position.

So far as labour and wages questions are concerned, the position has been comparatively quiescent during the past twelve months. The terms of settlement drawn up as the result of the great strike have worked exceedingly well on the whole, and prevented further serious disputes, any differences having for the most part been amicably settled. Some revision of the agreement has, however, been under discussion, and slight alterations in detail made, which will leave the relations of employers and workmen on a satisfactory basis.

American methods, and the systems of workshop organisation, both in the States and on the Continent, are, however, being brought to the front, as an important element in the keen competition which English engineers have now to face, and their introduction into English workshops and enterprise is perhaps the most critical question that will engage serious attention in the near future. An object lesson in this direction is likely to be furnished by the large British Westinghouse works in Trafford Park, when they get into full operation, as is anticipated, during the ensuing year. These works, it is understood, will be conducted entirely on American lines, and Lancashire engineering firms are keenly interested in the attitude the trade union organisations may take up on the matter. If the British Westinghouse Company can secure as many English operatives as they require to work on American lines, to which so much objection has been raised by the English trade unions, other firms will, of course, argue that they see no reason why they should not be able to carry on these operations under the same conditions, as this may lead to a keen struggle with the trade unions.

The monthly returns of the Amalgamated Society of Engineers show a further increase in the number of unemployed members throughout the organisation, which now represents nearly 3⅜ per cent., and a special appeal is made to the members that as trade remains quiet "it behoves all to be careful in behaviour, so as to keep the unemployed list down to the lowest possible limits." In the Manchester district, however, where there was last month a substantial increase in the number on benefit, there has been no further material addition to the list, the proportion being still about 5 per cent. The local delegate, in commenting on the present position, states that, taking the season of the year into consideration, when usually the society has an excessive number on donation, owing to circumstances over which the members have no control, there is perhaps little need of apprehension, seeing that they are evidently pretty well holding their own, so far as employment is concerned.

Briefly alluding to the operations of the society during the year now coming to an end, the general secretary observes that it has, on the whole, been a prosperous one in the engineering trade, and the Amalgamated Society of Engineers has again done well. There had been no expenditure of an abnormal character, and the members had paid all demands upon them with the loyalty which had always characterised them. If a special effort were made to reduce the amount of arrears before the end of the year, the annual statement would show a very considerable improvement in the position of the society, both absolutely and relatively to other trade unions.

Recently I referred to the vote of the men that is to be taken on the revised terms of agreement drawn up at the recent joint conference in London. It is now announced that a special circular will be issued to the members of the Amalgamated Society of Engineers on the matter in the course of a few days. In the meantime, the general secretary states that the fresh terms will be found to be, in some respects, slightly amended. The organising delegate for the Manchester district, in a short reference to the question, remarks that the workmen's representatives had made every effort to render the terms more acceptable, and in conformity with the wishes and desires of the members generally. How far they had succeeded was left to the judgment of the members. The Liverpool delegate expresses the opinion that the new arrangement will be found to be much more satisfactory than the one at present existing, and the London delegate observes that the terms have been re-drafted, and in some instances improved, though not to the extent the workmen's representatives desired and endeavoured to obtain. A good feeling was, however, shown, and any complaints they might have to make from time to time would be dealt with more expeditiously by conference than formerly.

I understand that the question of compensation for outworkers was also brought forward, and that this matter will be fully gone into as quickly as possible.

Business in the iron and steel trades is also just now to a considerable extent thrown out of its ordinary course by the holidays, and but few inquiries are coming on the market, which has been further unsettled by the collapse in Scotch warrants with the close of last week, this, of course, having put an additional check upon buying where merchants or consumers have no pressing necessity to cover. The sudden drop in Scotch warrants, which represented a fall of fully 7s. per ton on the week, and from which there has since been a slight recovery, has not appreciably affected other brands, unless possibly it may have indirectly tended to bring about a further giving way on the part of Lincolnshire makers, who have again reduced their foundry qualities 1s. on No. 3 and 6d. No. 4, without, however, touching forge numbers. Their quotations for Nos. 3 and 4 foundry and No. 4 forge on trucks are now precisely the same, and delivered Manchester, Lincolnshire foundry is now 49s. 6d. net, with forge qualities, delivered Warrington, unaltered, and firm at 50s. 2d. net. Lancashire and Derbyshire brands remain without quotable change from last week.

Middlesbrough, if anything, is perhaps a shade stronger, and 51s. 10d. net has been got readily for delivery by rail Manchester. Scotch makers' quotations are generally maintained, but have varied, Glengarnock being slightly stronger, with Eglinton, if anything, easier, and delivered docks, Eglinton could be bought at 57s., with Glengarnock quoted up to 60s. net.

There has been a considerable arrival of Canadian iron in the Mersey, a portion of which is going into the Warrington district, whilst parcels are also, it is stated, being taken by consumers in the Midlands. The reported prices for delivery Warrington remain about 49s. to 49s. 6d. net.

For finished iron only very slow inquiry is coming forward. The minimum association basis for Lancashire bars remains £6 10s., and North Staffordshire £6 15s. delivered here, but there are lower quotations in the open market. Sheets are weak at about £8. Hoops are unchanged at the recent list rates.

The business in the steel trade is also anything but brisk. Hematites are weak in price, 65s. 6d. to 66s. 6d. net being now about the quotations for No. 3 foundry, delivered here, with sellers prepared to take less to secure business. Local made billets remain about £4 15s. Warrington, and £4 16s. 3d. Manchester net. Steel bars range from £6 10s. to £6 12s. 6d; common plates average £6 12s. 6d., with £7 10s., less 2½, still the association basis for boiler plates, but outside sellers at under this figure.

In the manufactured metal market the drop in raw material has brought about a reduction of ¼d. to ⅜d. per lb. in list rates, seamless brass tubes being now on the basis of 7d., seamless copper tubes 9d., brazed copper tubes 8¾d., brazed brass tubes 8¼d., rolled brass 6¾d., brass wire 7d., copper wire 9d. per lb. delivered in this district.

An extreme pressure is reported for all descriptions of fuel, and owing to difficulties of delivery from collieries, both over the railways, by canal, and by road, and there is for the moment a shortness of supplies to meet requirements. This is causing a stiffening in the open market, with special prices quoted where consumers are compelled to get prompt deliveries. So far as the pit-quoted rates are concerned, they remain without official alteration, but are very firm at 15s. to 15s. 6d. best Wigan Arley; 13s. to 13s. 6d. Pemberton 4ft. and seconds Arley; 11s. to 11s. 6d. common house coal; 9s. to 9s. 6d. steam and forge coal; 8s. 6d. to 6s. common, and 7s. to 7s. 6d. best slacks, at the pit. Steam coal delivered Mersey ports averages about 10s. 6d. to 11s. per ton.

Coke is unchanged at late rates.

Barrow.—There is practically no change in the condition of the hematite pig iron trade. The trade is well employed, there being thirty-seven furnaces in blast, and makers are well off for orders, being sold forward to some extent. Not a deal of business has been done during the past week, the demand of late having quieted down. Stores at present stand at a lower level than ever before, but with the stoppage of steel works in this and other districts, iron will probably run into stock. Prices are much the same so far as makers are concerned, and they are quoting 58s. 6d. to 60s. per ton net f.o.b. for parcels of mixed numbers of Bessemer iron. In the warrant market prices are much easier, and sellers are quoting 55s. 6d. per ton net cash.

The steel trade is stopped for the time being on account of the holidays, and little business is being done or will be until after the New Year. Many inquiries are to hand for heavy and light classes of steel. Heavy sections of rails are quoted at £5 10s. per ton, with the heavy tram section at about £8 10s. per ton. Steel ship-plates of average weight are at £6 2s. 6d. per ton. Quotations, however, at present, are to a very great extent merely nominal.

Shipbuilders and engineers are also stopped for about ten days. At the Barrow yard new orders are wanted in some of the departments. The Japanese battleship Mikasa leaves Barrow this week for Portsmouth.

Iron ore is in good demand at from 11s. to 16s. per ton net at mines. Spanish ores are quoted at 15s. per ton for the best sorts. Coal and coke are in good demand at late rates.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE work of the year is now ended. The Christmas holidays began on Tuesday afternoon, and will be continued until the new year is in. In the colliery districts an effort is being made to get the men to return to work on Tuesday, December 31st, but it is not likely to be successful, while in our heavy local trades there is very little need for curtailing "play" time. The sudden advent of severe weather has had the effect of increasing the demand for house coal, but as the winter stocks were laid in a considerable time ago, there has been nothing like the "rush" which would otherwise have taken place. Still, the result will be to clear off accumulations and to give a firmer tone to the house coal trade in the beginning of the year. Heavy deliveries are being made on contract account for locomotive and gas coal. Most of the gas coal in the South Yorkshire district being fully contracted for, such gas companies as are holding out for easier terms will have to go elsewhere for supplies.

The coal trade closes for the year with values much below what were looked for, except in the case of manufacturing and house fuel. In 1900 coalowners commanded the market, and could get whatever price they pleased to ask; 1901 found business trending downwards, and this feature was accentuated as the year went on. Possibly the South Yorkshire coalfield suffered less severely than other districts, although the Northumberland and Durham coalowners succeeded in displacing a good deal of work by taking foreign contracts which have usually come to South Yorkshire. The imposition of the coal tax was another incident which caused considerable anxiety, but it cannot be said to have had grave prejudicial influence in the South Yorkshire district. Railway companies have now arranged their new contracts at 9*s.* per ton, against 14s. per ton for last year. In gas coal the reductions are about the same. Railway managers have done extremely well in renewing their contracts at 9*s.* per ton, as a shilling a ton more is freely obtained in the open market, and there is every prospect of higher values ruling before the summer of 1902.

In the coke trade the year's business opened unsatisfactorily. Nine months ago foundry coke fetched from 20s. to 22s. per ton; steel melting coke, 25s. to 26s.; blast furnace, 11s. to 12s. 6d. per ton. Prices continued to stiffen up to October, but ordinary coke is now only making from 10s. 6d. to 10s. 9d. per ton. The trade for the year has been less than usual, the hopes entertained of improving business growing weaker.

In the iron trade West Coast hematites opened in January at 82s. 6d. per ton, dropping in April to 69s. 6d., in July to 68s. 6d., and rising again in October to 71s., and closing on December 24th at 69s. These values show a considerable fall on those for the corresponding periods of 1900, when West Coast hematites opened at 93s. 6d. per ton, went up in April to 97s., fell in July to 96s., in October to 92s., and on December 24th to 82s. 6d. To get the equivalent values of North-East coast irons, 2s. 6d. per ton should be taken from the foregoing quotations. In common forge iron the opening value for this year was 67s. 6d. per ton, dropping to 45s. 6d. in April, at which price it continued until October, when the value was 47s. 6d.; at this price it still remains. These quotations compare with 70s. per ton on January 1st, 1900; 70s. remained the price up to April; in July it fell to 68s., in October to 60s. 6d., and in December to 57s. 6d.

Steel values do not call for much comment. The steel trade has been practically in a state of collapse all the year, not merely in the case of the Bessemer and Siemens steels, which are dependent upon the heavy trades, but also in regard to crucible steel. After a fall of 5s. per ton about the middle of the year, a slight improvement took place in the autumn, but values are again lower, Bessemer fetching £7 per ton, and Siemens steels £7 10s. to £14 per ton, according to quality and temper. In the higher grades of steel the demand has been very weak, more particularly the foreign demand, the German market, which takes the greatest value in the dearer steels, having shrunk to about one-third of its usual average. While the Germans have been taking less from us, they have been delivering their own makes of steel in constantly increasing weights. At this moment foreign-made basic steel is being delivered in Sheffield, and pretty largely used, at £1 per ton less than it can be bought in the city. Much heavier weights are being sent into the Black Country.

In military material the year has been anything but satisfactory. The plates for only two battleships and six first-class cruisers have been ordered this year. The battleships were H.M.S. Queen and H.M.S. Prince of Wales. The cruisers belonged to the County class, viz.:—Berwick, Cornwall, Cumberland, Donegal, Lancaster, Suffolk. The battleships are being built at Devonport and Chatham, the cruisers at Glasgow, Pembroke, Elswick, and Portsmouth. Last year the armour work in Sheffield was for nine battleships and eight first-class cruisers. A good deal of that work overlapped into 1901, when, in accordance with the urgent request of the Government, the orders were pushed forward with all possible expedition. Very soon, however, the whole were completed, and for a considerable time now operations in the melting furnaces, the rolling mills, and other places where the preliminary processes are done, have been suspended, and only in the planing shops have the men been employed. Much disappointment has been expressed locally over the lack of orders to keep the costly plant and skilled staffs employed; but the year closes with some prospect of fresh orders being placed very soon. A similar remark applies to ordnance and heavy projectiles, in both departments the activity with which the year opened having changed to languor.

In railway material the year has been quiet. Railway managers find expenditure increasing in all directions, while traffic has been unsatisfactory. They have thus been compelled to restrict their orders to immediate requirements. A little "spurt" in the middle of the year, when fuel became cheaper, led to better business, but the orders then received, chiefly on foreign account, have not been followed by others, and all departments of the railway trade are dull, not excluding local wagon builders, who have been affected by the adoption of steel wagons, and the preference shown by railway companies to the larger wagons used on the American lines. The Lancashire and Yorkshire Railway are reported to be constructing, at their Newton Heath works a number of these high-capacity wagons, to be used in certain descriptions of their goods and mineral traffic. When empty the wagons weigh 14 tons 15 cwt., and they are to carry a load of 32 tons, or more than equal to the loads of three standard four-wheeled wagons.

In the lighter trades of the city the year has been unsatisfactory, except with regard to specialities required on South African account. These have formed a considerable feature of the local cutlery and silver-plating trades. Two circumstances are looked forward to with hope by local manufacturers. One is the early close of the war, which will at once vitalise many industries now almost dormant; another is the succession of festivities expected during the Coronation year. The new year, however, will find manufacturers with very little work on their books, and the men will consequently have indifferent employment when work is renewed.

NORTH OF ENGLAND.

(From our own Correspondent.)

ALL business is very quiet now on account of the holidays, which are to be more prolonged than they have ever been at Christmas in recent years—an indication of a marked slackening in trade. Nearly all the shipyards and engineering establishments closed on Saturday, and they mostly will remain idle until the Monday after next—a full fortnight—as the pressure for delivery has gone off very considerably, seeing that freights are extremely low as a rule, and that employment cannot be found for anything like the number of vessels offering, and a good number are laid up in our ports. And the outlook for next year is not encouraging, so that owners are generally not in a hurry for their new steamers. This month, altogether, work at the shipyards has been more irregular than for some years past, because before the holidays the weather interfered a good deal with operations, and the workmen would have preferred shorter holidays. The holidays at the finished iron and steel works, partly on account of the stoppage of deliveries to the shipyards, will be more extended than usual, and as the blast furnaces have to be kept going as at ordinary times, some increase of the stock of pig iron must be looked for.

Considering the collapse of the price of Scotch pig iron warrants, the position in this district is very well maintained; in fact, the value of makers' iron has not been at all affected. There was, however, no good reason why it should be, for it must be remembered that the price of Cleveland warrants, influenced by the slackening trade, has been steadily falling for a long time, whereas that of Scotch warrants has been artificially maintained. The Scotch pig iron warrant market has been bolstered up mainly by a "ring" of London speculators, and has for long enough afforded no criterion of the actual condition of trade. That has been shown more by the fluctuations in the value of Cleveland warrants. The drop in Scotch warrants, when the collapse occurred a few days ago, only represented what has been going on in regard to Cleveland warrants for several months, and brings down Scotch to nearly the normal figure above Cleveland. This latter is about 4s. 6d.; but over most of the year the difference has been 8s. per ton; in November it was 13s. 6d., and for the greater part of this month has been over 12s. Some levelling down became necessary, as trade did not favour any advance in Cleveland iron. Such a collapse as has occurred was quite expected, and this has been precipitated by the report of the death by his own hands of one of the London speculators. In two days after that report there was a fall of 7s. 7d. per ton; and though there has since been a slight reaction, it is not likely that there will be any material recovery, the time of the year and the condition of trade being against that. The "bulls" will find that task insurmountable. The collapse will, however, tend to make the pig iron market more stable and healthy. All the weakening that the drop of 7s. 7d. per ton caused in the Cleveland market, so far as warrants were concerned, was 6d., and that has been recovered since.

Sellers of Cleveland No. 3 pig iron, both makers and merchants, have all through the disorganisation of the market held firmly to 43s. 6d., as their figure was not a fictitious one, like the Scotch warrant price had been. Besides, 43s. 6d. per ton is not a price that will cover cost of production; in fact, makers generally should be realising 46s. 6d. at least to enable them to do that, seeing that they have to pay 16s. 9d. per ton for coke alone, delivered on Tees-side, which means that the coke used per ton of pig iron made will cost not less than 20s. per ton. No. 4 foundry is at 43s. 3d., and grey forge at 43s. 6d. An increase in the stock of the latter will not be unwelcome, because for some considerable time there has been much difficulty in satisfying the requirements of consumers.

East Coast hematite pig iron has not further declined, and mixed numbers are still at 58s. per ton, which is a price that will barely cover the cost of production, chiefly on account of the dearness of coke, as other items of expenses have been reduced pretty nearly as much as the pig iron prices themselves. The West Coast competition is keener than it has been for some years, and makers here have had to reduce their prices to meet it. Spiegeleisen is at 87s. 6d. per ton, and ferro silicon at 82s. 6d. Rubio ore is at 15s. 9d. per ton, delivered at wharf Tees or Tyne.

Manufactured iron and steel prices are weak; indeed, steel plate makers have reduced their quotations 2s. 6d. per ton, and iron plates are also down as much. Angles have also been reduced, and now steel ship plates can be got at £5 17s. 6d.; iron ship plates at £6 7s. 6d.; steel ship angles at £5 12s. 6d.; and iron ship angles at £5 17s. 6d. per ton, all less 2½ per cent. Common iron bars are steady at £6 5s. per ton, less 2½ per cent., a figure which has ruled for more than half a year. Heavy steel rails are at £5 10s.; steel railway sleepers, £6 5s.; and cast iron chairs, £3 7s. 6d. per ton, all net at works.

Gjers, Mills and Co., Ayresome Ironworks, Middlesbrough, and Spa Ironstone Mines, Guisbrough, have converted their business into a private limited company, the shares being all held by the partners and their co-signatories. The new company takes over the concern on January 1st next, and it will be managed as hitherto, under the personal supervision of Mr. Laurence F. Gjers and Mr. J. Vernon Cooper. Mr. John Mills, who, with the late Mr. John Gjers, founded the concern, will be the chairman of the company, and the other directors are Messrs. L. F. Gjers, J. V. Cooper, and Charles E. Mills.

One of the results of the visit of the North-Eastern Railway Company to the United States has been the determination to install the Hull automatic electric signals on a short section near York for experimental purposes. Automatic signalling is extensively adopted in the United States. The company will also follow the Americans in compiling particulars as to the passenger mileage, ton mileage, and train-load results.

The closing year has been generally an unsatisfactory time—in fact, the extent of the trade in this district has been smaller than in any year since 1895. In 1899 our trade was the most extensive ever known, while last year was distinguished for the excellence of the prices obtained, those in the first half being the best that had ever been reported for more than a quarter of a century. The first year of the new century has, however, been a period remarkable for the falling off both of demand and prices. The downward movement commenced in the summer of 1900, and has been going on ever since. Prices, which went up so rapidly in 1899 and the

first half of 1900, have, during the year now closing, fallen with equal celerity; deliveries of pig iron to oversea countries have been the worst since 1894; local consumption has also declined, and though the pig iron production was reduced considerably—10 per cent. at least—yet stocks in the public warrant stores have been increased over 89,000 tons. Wages of ironstone miners have been reduced 29 per cent.; wages of blast furnacemen, 29½ per cent.; foreign ore imports have been reduced 25 per cent.; finished iron and steel workers' wages have been reduced 17½ per cent. Pig iron shipments to countries abroad fell off 37 per cent.; quotations for No. 3 Cleveland pig iron fell off 35 per cent. If we compare the figures of production and shipment in 1901 with those for 1899 the decline is much greater. The exports of pig iron, in fact, this year have been 20 per cent. less than those of 1899, and the deliveries oversea were 40 per cent. less.

Foreign competition has troubled the traders of this district more than ever before. Canadian pig iron has not come into the North of England, but it has been received in Scotland to the extent of over 30,000 tons, and that will have taken the place of so much Cleveland iron. Scotland has this year taken about 427,000 tons of Cleveland pig iron, or more than was ever before known, but probably 450,000 tons would have been sent if the Canadians had not stepped in. Germany has sent into Middlesbrough some cargoes of basic pig iron, and not only that, but steel plates, bars, and billets. On Tyneside also German steel plates have been imported. One reason given for these imports was that local supplies were short, and deliveries of foreign material could, at the time, be more promptly obtained than could material from the neighbouring works. Thus, the competition of continental manufacturers had not had such a disquieting influence on producers here as might have been expected.

It is to be noted that during the year the success of the manufacture of steel from Cleveland iron suitable for all purposes has been assured. It can now be worked up into any form for which acid steel from hematite pig iron has hitherto been solely used. About 100,000 tons have now been made by Messrs. Bell Brothers, Limited, and Messrs. Dorman, Long and Co., Limited, Middlesbrough, all of which has been rolled into angles, girders, bulbs, tees, &c., which have been satisfactory in all respects, and the cost compares favourably with acid steel. The process is a modification of the basic open-hearth process.

The coal trade is quiet this week on account of the holidays and the great curtailment of consumption; but up to this week business was very active, and prices show no sign of declining, though they are relatively a good deal dearer than the prices most of the consumers can get for their produce. Best steam coals are 12s. per ton f.o.b., and gas coals 12s. 6d. Medium furnace coke is at 16s. 9d. per ton, delivered at the Teesside furnaces.

The following is a list of the marine engineering firms on the Tyne, Wear, Tees, and the Hartlepools, with the indicated horse-power of the engines they have constructed this year:—

Tyne.

	Indicated horse-power.
North-Eastern Marine Engineering Company, Limited	86,036
R. and W. Hawthorn, Leslie and Co., Limited	63,500
Wallsend Slipway and Engineering Company, Limited	46,650
Palmer's Shipbuilding and Iron Company, Limited	39,050
J. Wigham, Richardson and Co., Limited	20,200
J. Readhead and Sons	12,300
R. Stephenson and Co.	5,500
G. T. Grey	4,374
J. P. Rennoldson and Sons	3,337
Shields Engineering Company	1,950
J. T. Eltringham and Co.	1,940
Hepple and Co.	1,050
Hedley and Boyd	540

Wear.

George Clark and Co., Limited	48,770
John Dickinson and Sons, Limited	31,044
James Laing and Sons, Limited	21,353
Wm. Doxford and Sons, Limited	18,100
MacColl and Pollock	10,000

Tees and Hartlepools.

Richardsons, Westgarth and Co., Limited	120,150
Blair and Co., Limited	62,000
Central Marine Engine Works, Limited	47,700

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market of Glasgow has been completely demoralised by the failure of a firm of brokers, who were largely interested in Scotch warrants. Subsequently to the announcement of the failure, prices gave way to a considerable extent, and afterwards there was a very smart drop, the entire fall being as much as 7s. 3d. per ton. This extraordinary fall in price naturally put a stop to regular dealing, and now that the holidays are upon us there is very little business doing.

The fall in Scotch warrants was from 55s. 10½d. to 48s. 7½d. per ton. Cleveland pigs have been comparatively steady, with business from 43s. 3d. to 43s. 6½d., buyers latterly offering to sell at 43s. 1½d. per ton. There is very little doing in Cumberland hematite pigs, which have been quoted from 56s. 5d. to 56s. 8½d. per ton.

Prices of Scotch makers' pigs are nominally unchanged. G.M.B., No. 1 is quoted at Glasgow, 54s. 6d.; No. 3, 51s.; Govan, No. 1, 56s.; No. 3, 51s.; Carnbroe, No. 1, 57s.; No. 3, 53s.; Clyde, No. 1, 66s.; No. 3, 56s.; Gartsherrie No. 1, 67s.; No. 3, 56s. 6d.; Calder, No. 1, 67s.; No. 3, 56s. 6d.; Langloan, No. 1, 70s.; No. 3, 59s.; Summerlee, No. 1, 70s. 6d.; No. 3, 58s.; Coltness, No. 1, 71s. 6d.; No. 3, 58s. 6d.; Glengarnock, at Ardrossan, No. 1, 66s.; No. 3, 56s.; Eglinton, at Ardrossan or Troon and Dalmellington at Ayr, No. 1, 56s.; No. 3, 53s. per ton.

The demand for Scotch hematite pigs has been fair and prices are a shade firmer. Merchants quote 61s. per ton for delivery in railway trucks at the steel works.

The shipments of pig iron from Scottish ports in the past week have been 3792, tons against 4067 in the corresponding week of last year. The total shipments to date are 257,253 tons, showing a decrease of 63,011 tons compared with those of last year. The arrivals of Middlesbrough pigs at Grangemouth were 6599 tons, being 3094 more than in the corresponding week, and there is a total increase in arrivals for the year of no less than 165,131 tons.

There is a fair amount of activity in the manufacturing departments of the iron and steel trades. The works will be kept going in Scotland practically the whole of the present week, but will be closed the following week for the New Year holidays. There is naturally no fresh development in business. The demand for both finished iron and steel is quiet at the moment, and prices are nominally without change.

The coal trade has been active throughout the past week. Household sorts are in specially good demand, owing to the very cold weather. Manufacturing consumers have also been taking good supplies hitherto, but there will be less doing on their part in the next few days. The coal shipments show a considerable decrease compared with the corresponding week. Prices of all kinds of coals are quoted without alteration.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THERE is a strong belief amongst ironmasters that the steel bars and billets now being imported into Wales from Germany are being sold under prime cost. The only effect upon quotations has been to lower Welsh bars 2s. 6d. Ironmasters rely upon the superior bar made here to counteract the rivalry, and I find that the demand for Welsh make is tolerably good. Rails are also in evidence, nearly 2000 tons going to Alexandria on Saturday last, and some of the mills in the Bessemer district were busy at the close of the week upon a substantial steel rail for the Great Western Railway. This rail is about 76½ in weight, and 46.6 in length, a precursor, as I stated lately, to the 100 lb. rail which may be expected soon to come into use. Barrow has been shipping pig iron and ingot moulds to the Swansea district, and Newport received at the close of the week 1050 tons pig iron from Barrow, 1460 tons German billets, and 100 tons iron billets from Sweden. A good cargo of steel rail has just been shipped to Cork from Newport.

It is understood in the Dowlais district that one immediate result of the amalgamation of the Dowlais and Patent Nut and Bolt Works will be a change in the medical officer's arrangements. Up to the present the doctor's fees are kept back from the workmen's wages in the office. The future plan is to be irrespective of the company, and will be an arrangement between the workmen and the medical staff. This is now being debated over a wide radius, as, if carried out at one works, the probability is the adoption elsewhere, and the ending of the old works' doctor monopoly.

The sheet iron trade between Newport, Mon., and Bristol is well maintained. In one day last week 610 tons were forwarded.

An important meeting of the Tin-plate Trade Wages Dispute Board was held in Swansea last week, when various matters of interest were discussed. One of these was the statement that at the Avondale and Tynewydd Works plates were worked at 12½ per cent. below the 1874 list. The result of this, it was stated, was these works secured all orders for a particular size. After a discussion it was resolved, that application should be made to the secretary to demand that similar rates be paid to those at other works.

The Tin and Sheet Millmen's Union, I understand, have practically decided to hold aloof from amalgamation with the Steel Smelters' Union, and pay off the remaining debt of £300 on the old union.

Liverpool is quoting this week tin-plate in Wales at following prices:—Black plates, £9 15s. per ton, with drooping tendency; Bessemer cokes, per box, 12s. 9d. to 13s.; squares and odd sizes, 13s. 6d.; basic, Siemens coke, 14 by 20, 13s.; charcoal tins, 14s. and upwards; ternes, 24s. 3d.

No quotations issued from Exchange, Swansea, in time for despatch.

Price, with one exception in the iron and steel trade, may be regarded as unchanged. The exception is Glasgow pig iron warrants, which were quoted in my last from the notification issued by the Swansea Exchange as 56s. 3d. Owing to the sudden "collapse of the rig" which has taken place, the quotation is now 48s. 9d. Glasgow. On 'Change, Cardiff, this week holiday influences were perceptible, and little business done. Coalowners were quite content with the outlook, and buyers who expected to get forward business done for the first, and some the second month of the New Year, were unable to do so except at firm prices. Coalowners stated on 'Change that they were quite satisfied with the booking done for January. The close of the week saw some heavy shipments for coaling stations, Port Said being the destination of over 20,000 tons.

Swansea coal quotations were not issued in time for despatch. Trade fairly brisk, chiefly to France.

Pitwood at Cardiff is rather weak in tendency, but this is not likely to last, as there are strong indications of stormy weather. Prices are now from 16s. 9d. to 17s. 3d.—a "drop" of 3d. Saturday.

Latest coal prices obtainable Cardiff are as follows:—Best steam coal, 16s. 3d. to 16s. 9d.; good ordinaries, from 16s.; other kinds, from 15s. 6d.; drys, 15s. 9d. to 16s. 6d. Best Monmouthshire, large coal, 15s. 3d. to 15s. 9d.; seconds, 13s. 9d. to 14s. 9d., both *rid* Cardiff. Best house coals, 16s. to 17s.; seconds, 14s. to 15s.; No. 3 Rhondda, 16s. 6d. to 17s.; through and through, 13s. 6d. to 14s. 6d.; smalls, 11s. to 12s.; No. 2 Rhondda, 13s. 6d. to 14s.; through, 10s. 6d. to 11s. 6d.; smalls, 9s. to 10s.

Best small steam prices keep up well; latest figures are 10s. 9d. to 11s. 3d, though good ordinaries are obtainable at 10s. to 10s. 6d., and inferior from 8s. 6d.

Patent fuel is at 14s. 6d. to 15s. 6d.; fair demand. Newport is sending away good cargoes.

Coke quotations are maintained 16s. to 23s. Freights to Marseilles remain about 5s.

Details of the Rhymney Railway Bill have now been deposited for next session. Powers have been previously obtained, I note, but not exercised, and in consequence of their having lapsed, permission is again to be sought. One is for a junction with the private railway of the Powell Duffryn Company, another in connection with the Tredegar Iron and Coal Company, other lines will form junctions with the Walnut Tree Branch, one forming a link with the Barry. The Barry Railway Bill contains an important clause in this Bill, which is chiefly for extension of time. This clause is, briefly, that in the case of all steam vessels touching at any of the ports of the company, the net register tonnage shall in no case be reckoned at less than 40 per cent. on the gross tonnage. Brecon Railway Company has put in a Bill to capitalise arrears of outstanding interest on its debenture stock, and the liquidation by the issue of an equal nominal amount of its debenture stock.

The hydraulic equipment at Llanelly Docks on Saturday met with a serious accident, the large accumulator falling, and leading to a complete congestion of business at the docks.

In reference to the notice, given in my last, of the intention of the colliers to take four days' holiday this week, the Tredegar Company issued on Monday a notice respecting the McLaran Collieries, that the only Christmas holidays which would be permitted would be Christmas Day and Boxing Day. The Powell Duffryn Company worked overtime on Monday and Tuesday.

The impression in the district is that the notice by the Tredegar Company is practically that of the Federation, and that at their meeting, which will take place this week, a general notice to the same effect will be issued.

At the quarterly meeting of the Miners' Provident Fund, held in Cardiff on Saturday, it was shown that the number of members up to September 30th was 31,627. During the quarter there had been twenty fatal accidents, resulting in the death of twenty members. At the present 923 widows and 1164 children are in receipt of relief.

The Mount Stuart new dry dock, which has now been completed and equipped with the latest appliances, received its first steamer on Saturday. Mr. James Allan was the constructor, under the superintendence of the able resident engineer, Mr. Evan Jones.

I have been favoured with a well-got-up brochure, issued by Mr. C. D. Phillips, of the Emlyn Works, Newport, whose works at the visit of the Junior Engineers, on the occasion of their South Wales trip, made a very favourable impression.

The Taff Vale Railway Bill has just been deposited. By it, the promoters seek power to construct a new railway and to acquire lands, to obtain running and other powers, and for vesting in the Taff Vale Railway the undertaking of the Aberdare Railway Company.

NOTES FROM GERMANY.

(From our own Correspondent.)

THERE is no change whatever to report with regard to the iron trade over here. Home demand continues extremely limited, and has generally shown a falling off against previous weeks. Denmark, Norway, and Roumania, have been pretty good customers lately, having bought rather freely on the German market; also to Egypt some sales have been effected, whereas Russia is but a poor buyer now. At a recent tendering for the Dutch State Railways three German works, the Machine Works, Augsburg, the Machine Building Company, Nürnberg, and the Dortmund Union, tendered; the last-named firm, offering lowest at 8700fl., obtained the contract, the other two works having asked 10,700fl. The continued underquoting among the different iron-works, which, in many instances, leads to a reduction in prices, has recently compelled the Berlin dealers to go down with their prices, and they are now selling plates at M. 2·50 and sheets at M. 1 p.t. less than formerly. Scrap iron has been in improving request, especially in Silesia; foreign demand was particularly strong during the past few weeks, and this has caused a fair decrease in stocks, and quotations have moved upwards, M. 5·50 per 100 kilos. having in some cases been realised; the price generally paid is, however, M. 4·50 per 100 kilos.

Business comes forward only very slowly on the Austro-Hungarian iron market. Many works have been forced to dismiss a large number of their men, and ironmasters consider themselves very fortunate if the orders they secure are sufficient to keep the shops and forges partially engaged. Prices are the same as in previous weeks; the fact that they have not changed need not be considered as a favourable symptom—on the contrary, it is rather because makers have hardly had an opportunity of reducing them, as the number of inquiries received upon the week has been so ridiculously small.

The commercial feature in Belgium is, like that in most other countries, very unsatisfactory. Activity at the various establishments is moderate, and the feeling in all industries has shown much weakness of late. The locomotive and wagon shops have contracts for some months ahead in a number of instances, but the majority of the mills and foundries complain of the scarcity of fresh work and of the almost total absence of forward orders. The want of enterprising spirit and the general feeling of distrust with regard to the future become more marked every week, and makers of iron and steel do not think it at all likely that a better tone will be felt till, perhaps, in early spring. There may be a slight improvement noticeable for some articles now and then, but anything like a sound trade is out of the question until the revival has become more general and the German inland demand has again become healthy and strong, so that German ironmasters need not compete so fiercely on foreign markets.

The extraordinary quietness in all departments of the iron and steel industry could not fail to have a most depressing influence on the Belgian coal market. In engine fuel quotations have shown much weakness; the rough weather of the last few weeks was, however, favourable to the business in house coal, and a good number of contracts have been booked. Prices are inclined to stiffness, and they are even expected to move upwards if severe frosts set in. Coking coal is also firm, and so is coke.

Some ironworks are busy in France, but the greater part of the iron-producing establishments can only be kept going very moderately, consumers, as a rule, buying only small lots. But manufacturers expect to do a better business after New Year; even if the eagerly wished-for improvement does not set in, there is sure to be a better inquiry coming forward for some articles of steel, such as girders and general railway rolling stock, and the shops engaged in the manufacture of these articles consider the outlook by no means dull, and some are even said to entertain quite a hopeful view of next year's trade.

It is reported from St. Petersburg that the Russian Minister of Finance has refused to grant the request of the manganese works concerning the reduction of the tariff for manganese ore on the Tschiaturian branch of the Kaukaisian railways.

LAUNCHES AND TRIAL TRIPS.

EPSOM, steamer; built by, Ropner and Son, Stockton-on-Tees; to the order of, Britain Steamship Company, Limited; dimensions, 383ft. 7in., 50ft. 6in., by 31ft.; to carry, 7100 tons on Lloyd's summer freeboard; engines, triple-expansion, pressure 200 lb.; average speed, 11½ knots; trial trip, December 20th.

THESPIS, steel screw steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, Lamport and Holt, Liverpool; dimensions, 390ft., 50ft., by 29ft. 6in.; to carry, 6540 tons deadweight; engines, triple-expansion, 27½in., 46in., 74in., by 54in. stroke, pressure 200 lb.; constructed by, Richardsons, Westgarth and Co., Limited; trial trip, December 23rd.

BURGEMEESTER JACOB, steel screw steamer; built by, Ropner and Sons; to the order of, Scheepvaart Maatschappy Neptuns, of Rotterdam; dimensions, 336ft., 48ft., 24ft. 3in.; to carry, 5200 tons deadweight; engines, triple-expansion, 24in., 38in., 64in. by 42in., pressure 160 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch, December 24th.

MINAS, steel screw steamer; built by, Craig, Taylor and Co., Limited; to the order of, Sociedad Espanola de Minas, of Bilbao; dimensions, 278ft., 40ft. 8in., 20ft. 6in.; to carry, 3000 tons deadweight; engines, triple-expansion, 20in., 33in., 54in. by 39in., pressure 160 lb.; constructed by, North-Eastern Marine Engineering Co., Limited; launch, December 24th.

GRANTLEYHALL, steel screw steamer; built by, Irvine's Shipbuilding and Dry Docks Co., Limited; to the order of, West Hartlepool Steam Navigation Company, Limited; dimensions, 360ft., 47ft. 9in., 30ft. 2½in.; engines, triple-expansion, 25in., 40in., 67in. by 45in., pressure 165 lb.; constructed by, Richardsons, Westgarth and Co., Limited; launch December 24th.

AKABO, mail and passenger steamer; built by, Sir Raylton Dixon and Co., Limited; to the order of, Elder, Dempster and Co.; dimensions, 364ft., 44ft., 26ft.; engines, triple-expansion, 27in., 43in., 72in. by 48in.; constructed by, Richardsons, Westgarth and Co., Limited; for the African trade; launch, December 24th.

SOCIETY OF ARTS, SESSION 1901-1902.—The following are the arrangements for meetings during January and February, 1902:—Wednesday, January 1st and 8th, 5 p.m.—Juvenile Lecture—Sir Henry Trueman Wood, M.A., "Photography and its Applications." Monday, January 13th, 20th, 27th, and February 3rd, 8 p.m.—Cantor Lecture—Samuel Rideal, D.Sc., "The Sterilisation of Water." Wednesday, January 15th, 8 p.m.—Ordinary Meeting—Frank J. Gray, A.M. Inst. C.E., "Elliptographs." Tuesday, January 21st, 8 p.m.—Applied Art Section—Halsey Ricardo, "The Use of Enamelled Tiles from an Architect's Point of View." Wednesday, January 22nd, 8 p.m.—Ordinary Meeting—Rev. J. M. Bacon, "Scientific Observations at High Altitudes." Thursday, January 23rd, 4.30 p.m.—Indian Section—F. H. Skrine, "Bengal: The Land and its People." Tuesday, January 28th, 4.30 p.m.—Colonial Section—Commander B. Whitehouse, R.N., "Mombasa to Uganda by Railway and Lake." Wednesday, January 29th, 8 p.m.—Ordinary Meeting—Clayton Beadle, "Technical Education as applied to Paper Making." Tuesday, February 4th, 4.30 p.m.—Applied Art Section—Rev. Herbert Thurstan, S.J., "The History of the Rosary in all Countries." Wednesday, February 5th, 8 p.m.—Ordinary Meeting—Herbert T. Thomas, "Jamaica." Thursday, February 6th, 4.30 p.m.—Indian Section—Professor Wyndham R. Dunstan, F.R.S., "The Coal Resources of India." Monday, February 10th, 17th, and 24th, 8 p.m.—Cantor Lecture—Cyril Davenport, "Personal Jewellery from Pre-historic Times." Wednesday, February 12th, 8 p.m.—Ordinary Meeting — William Leonard Madgen, "Industrial Redistribution." Tuesday, February 18th, 4.30 p.m. — Colonial Section—W. T. R. Preston, "The French-Canadian Relationship to the Crown." Wednesday, February 19th, 8 p.m.—Ordinary Meeting—Erie Stuart Bruce, M.A., "The Use of Balloons in War." Wednesday, February 26th, 8 p.m.—Ordinary Meeting—Professor Roberts Beaumont, M.I. Mech. E., "Recent Inventions in Weaving Machinery." Thursday, February 27th, 4.30 p.m.—Indian Section—Nilkanth B. Wagle, B.A., "The Industrial Development of India."

CATALOGUES.

CHARLES E. SCHLIMPER, Colchester.—New catalogue of the Reliance donkey pump.

BERLIN-ANHALTISCHE MASCHINENBAU-ACTIEN-GESELLSCHAFT, Dessau. Catalogue No. 265 of shafting and pulleys, hangers, brackets, couplings, &c.—This little book, although produced in Germany, is printed in good English, and contains much useful information. The London agent is Mr. W. P. Goodale, Leadenhall-street, E.C.

COTHIAS ALLOY COMPANY, Ivry-sur-Seine, France.—Catalogue of finished castings made in various hard alloys of high tensile strengths. These are cast in metal moulds, are useful for repetition work, as it is claimed that they can be cast to within $\frac{1}{100}$in. in variation. The English agents are Messrs. Norman and Young, 36, Camomile-street, London.

CLYDE STRUCTURAL IRON COMPANY, Limited, Scotstoun, Glasgow. Catalogue of structural iron and steel work.—The illustrations are made from photographs of actual structures which have been erected in many parts of the world, and include agricultural buildings, gold mine buildings, railway stations, grand-stands, iron foundries, boiler shops, &c. &c.

THOS. W. WARD, Albion Works, Sheffield.—Catalogue of constructional iron and steel work, roofs, bridges, piers, rolled steel joists, columns, and stanchions, of rolled steel sections, plate, lattice, and compound girders, steel work for colliery pit head frames, cages, hoists, staircases, &c. &c. This is something more than a trade catalogue. It is intended to assist architects, builders, engineers, &c., in selecting suitable sections without searching for the desired data among a mass of tables and general information. It is, in fact, a model from which the compilers of similar publications may find something to learn.

UNION ELECTRICAL COMPANY, Limited, 151, Queen Victoria-street, London, E.C.—List No. 22, dealing with 8-pole dynamos and motors, covering a range of from 75 to 405-kilowatt generators and from 95 to 520 horse-power motors. Each machine is constructed upon a principle that allows the same machine to be supplied at from five to seven different speeds without any variation in the price. This is due to a systematic standardisation in the windings, and enables the generators to be applied to standard engines of any power, and the motors for driving by direct-coupled machines running at any desired speed. Beyond that, each machine is so constructed that it can be finished in five different manners: (1) With belt or rope driving; (2) with two bearings, a bed-plate and halt coupling; (3) with one bearing, bed-plate and half coupling; (4) with one bearing, the outer one, and no bed-plate; (5) without bearing or bed-plate or shaft. In this case the armature is intended to be pressed on the shaft which drives it, or which it drives.

ALMANACS, CALENDARS, &c.

THE Hunslet Engine Company, Leeds, has conformed to its usual custom in the matter of design, which is as neat as can be desired. The calendar is printed on monthly slips.

OF a more ornate character is the calendar from Wyckoff, Seamans and Benedict, the makers of the Remington typewriter. The central coloured plate is very attractive, and the calendar itself is neat and legible.

FROM E. R. and F. Turner, Limited, Ipswich, there has come to hand a small calendar for next year of this firm's usual type. It is of the block pattern, with daily tear-off slips, on each of which is printed a motto.

THE *Chemical Trade Journal* has issued a wall calendar in which the dates are clearly printed, but the general effect of which is marred by a crowd of advertisements, by which the useful portion of the calendar is surrounded.

MR. JOHN ETHERINGTON, of 39A, King William-street, London, has published a calendar in which no attempt is made at the picturesque. It is simply a clearly printed monthly block calendar, the back of which has been modestly utilised for calling attention to his engineering specialities.

THE firm of McCorquodale and Co., Limited, is issuing the annual shilling publication known as the Railway Diary and Officials' Directory. This book contains much information of use in railway management, and the diary for notes. The Railway Wall Almanac is produced in the same offices.

WE have received from the Electrical Power Storage Company, Limited, an acceptable blotting pad and diary, which carries with it a free insurance for £500 against railway accidents. The blotting pad and diary form an excellent idea, and it is surprising that it does not meet with more general adoption by engineering firms.

THE Gloucester Railway Carriage and Wagon Company, Limited, has sent us a copy of the Gloucester Diary and Directors' Calendar for 1902. This is the seventh year of issue, and the features which have become familiar are retained. The little book will be found highly useful by railway men. Perhaps it would be an improvement if black ink had been used instead of blue.

TRADE AND BUSINESS ANNOUNCEMENTS.

SIR ALEXANDER R. BINNIE, M. Inst. C.E., intimates that in future his address will be 9, Great George-street, Westminster, S.W.

THE Electric Lighting Boards English Company announces that its French representatives were able at three days' notice to instal the entire electric lighting system of the numerous stalls at the great automobile exhibition in the Grand Palais of the Champs Elysee, the number of lights applied in this limited time being no less than six thousand. Both the technical and the daily Press of Paris consider the achievement a remarkable one, and above any French time record, even including the company's rapid installations at Compiègne on the occasion of the Czar's visit.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

. When inventions have been "communicated" the name and address of the communicating party are printed in italics.

10th December, 1901.

25,179. WINDING MACHINE for SILK, J. H. Young, London.
25,180. INCANDESCENT GAS BURNERS, E. W. Phelps and T. Nadeau, London.
25,181. FILLING CHOCOLATE MOULDS, A Reiche, London.
25,182. ELECTRIC MOTORS, G. Brewer.—(*E. R. Taylor, United States.*)
25,183. HEAT EXCHANGING APPARATUS, C. W. Ramstedt, London.
25,184. FILLING the TANKS of VEHICLES, W. B. Mason, London.
25,185. DETACHABLE HALF-SOLE for BOOTS, G. H. Tiller and F. S. Yates, London.
25,186. ACCELEROMETERS, The British Thomson-Houston Company, Limited.—(*F. B. Corey, United States.*)
25,187. CHROMIC SILICON STEEL, A. G. Brookes.—(*C. Casper and F. Oertel, Germany.*)
25,188. ANTI-FOULING COMPOSITIONS, J. C. Robinson, London.
25,189 STRENGTHENING PAPIER MACHE, A. Johnston, London.
25,190. PHOTOGRAPHIC APPARATUS, H. C. Braun and E. Esdaile, London.
25,191. DISPLAYING MOVING PICTURES, H. C. Braun and E. Esdaile, London.
25,192. JAQUARDS for WEAVING LOOMS, H. Mackintosh, Liverpool.
25,193. UTILISING GAS ENGINE HEAT, G. Andrews, Liverpool.
25,194. STUDS, R. Bentham, Liverpool.
25,195. BOTTLE-CLEANSING MACHINES, C. H. Loew, Liverpool.
25,196. SAFETY DEVICES for SWITCHES, S. Rogozes, Liverpool.
25,197. ROTARY ENGINE, A. M. Sage and D. H. Fairbanks, London.
25,198. BURIAL CASKET LOWERING DEVICE, W. H. Wheatley.—(*The Bowgardner Lowering Device Company, United States.*)
25,199. EXPLOSION ENGINES, G. Lord, jun., London.
25,200. MENSTRUAL RECEPTACLE, &c., J. R. Lang, London.
25,201. RECORDING DEVICES, P. A. Newton.—(*J. D. Keiley, United States.*)
25,202. STEAM SURFACE CONDENSERS, W. C. Brown, London.
25,203. ENVELOPES and POSTAL WRAPPERS, R. Ross, London.
25,204. IMPROVED COIN-FREED APPARATUS, F. Isaac, London.
25,205. LATTICE or EXTENSIBLE DOORS, D. Doyen, London.
25,206. COPYING MATERIALS, E. Aumont, London.
25,207. LIGHTING PIPES, J. Walton and J. D. Hannah, London.
25,208. ELECTRIC WELDING APPARATUS, H. Bosshard, London.
25,209. SKIRTS, G. Schadler, London.
25,210. FIRE-RESISTING COVERING for WOOD, A. Bellchambers, London.
25,211. TABLE TENNIS, C. F. J. Lock, London.
25,212. SCHOOL DESKS, A. Embretsen, London.
25,213. MEASURING INSTRUMENT, T. P. H. Ferguson, London.
25,214. TUBES for RADIATORS, J. Tarpin and H. Boyer, London.
25,215. TELEPHONE RECEIVER, F. J. Ott, London.
25,216. IDENTIFYING CONTENTS of GLASSES, J. Lyons, London.
25,217. METHOD of STOPPERING BOTTLES, J. Tansley, London.
25,218. RESISTANCE COILS, G. W. Johnson.—(*The Electric Controller and Supply Company, United States.*)
25,219. CONTROLLING ELECTRIC MOTORS, G. W. Johnson.—(*The Electric Controller and Supply Company, United States.*)
25,220. APPARATUS for COUNTING COINS, H. Graepel, London.
25,221. ALTERNATE CURRENT MOTORS, A. Heyland, London.
25,222. GRINDSTONES, H. W. and R. Phipps, London.
25,223. PHOTOGRAPHIC WASHING APPARATUS, C. Klein, London.
25,224. TABLE TENNIS APPARATUS, J. H. Chandler, London.
25,225. TRAMCARS, J. Ducimetière, London.
25,226. CARBURETTERS, C. Raney, London.
25,227. ELECTRIC INSTALLATION FITTINGS, J. Meehan, London.
25,228. ROTARY ENGINES, W. Foggo, London.

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25,229. PAPER CAPSULES for BOTTLES, F. Healey, London.
25,230. PRODUCTION of CARRIAGE LAMPS, F. Goodwin, Birmingham.
25,231. STEAM BOILERS, G. J. Gibbs, York.
25,232. LIFE-SAVERS for TRAMWAY CARS, A. J. Dawson, Dundee.
25,233. COMPOUNDS for BLASTING PURPOSES, W. Bate, London.
25,234. FIXING PHOTOGRAPHIC FILMS, S. G. Livett, London.
25,235. DUST EXCLUDER for HYDROS, B. Lord and E. W. Collier, Leyton, Essex.
25,236. RAILWAY WAGON BRAKE, J. Moughton and W. Jones, Manchester.
25,237. BALL VALVES and LEVERS, P. C. Jones, Guildford.
25,238. TOOL HOLDERS for LATHES, C. Scharenberg, Manchester.
25,239. PORTLAND CEMENT, C. Heap and T. Oddy, Manchester.
25,240. ADVERTISING MACHINE, J. B. Leatherbarrow, Manchester.
25,241. DRILLING MACHINES, R. Scaife and S. Ride, Burnley.
25,242. MACHINES for FOLDING PAPER, E. Hirst, Bradford.
25,243. TRAMCAR SEATS, J. Bentley and D. Bottomley, Bradford.
25,244. CANS, J. M. Munro, Limited, and R. McKirdy, Glasgow.
25,245. SEALING STOPPERS, C. Chambers, Birmingham.
25,246. ATTACHMENT for TAPS, C. Chambers, Birmingham.
25,247. VENTILATING COWL HEAD, A. W. Stewart, Glasgow.
25,248. PREVENTING LOCAL PRODUCTION of COLOUR, E. Knecht and P. Spence and Sons, Limited, Manchester.
25,249. PEDALS for VELOCIPEDES, W. Starley, Coventry.
25,250. WIPE-DRY for SEATS, R. Peacock and J. J. Rider, Manchester.
25,251. NECKTIES, J. W. Needham, Sheffield.
25,252. CLEARING FLOUR-MILLING MACHINES, B. Ramshaw and W. Bailey, Sheffield.
25,253. STUDS and SOLITAIRES, T. H. Shiner, Birmingham.
25,254. CYCLE CRANKS, A. W. Nightingale, Edinburgh.
25,255. SURFACE CONDENSERS, W. Shore, Hanley, Staffs.
25,256. CRIMPLED FABRICS, F. H. Gornall and W. A. E. Crombie, London.
25,257. BRAKE, W. A. Mercer, London.
25,258. WINDOW SASHES, J. B. Le Maitre, Birmingham.
25,259. CRUSHING MACHINES, T., R., and W. Lees, Manchester.
25,260. CUFF PROTECTORS, C. F. England, Bristol.
25,261. RAIN-WATER TAOUGHING for BUILDINGS, W. Whalley, Burnley.
25,262. NON-AUTOMATIC COUPLING for RAILWAY WAGONS, A. E. Dibb, London.
25,263. GALLEYS for MONOTYPE MACHINES, J. Esson, London.
25,264. LATHE-DOG, K. G. Holst, Kingston-on-Thames
25,265. ELECTRIC ARC LAMPS, The British Thomson-Houston Company, Limited.—(*W. C. Fish, United States.*)
25,266. ELECTRIC ARC LAMPS, The British Thomson-Houston Company, Limited.—(*E. Thomson, United States.*)
25,267. LOCKING SCREW NUTS on SCREW BOLTS, F. H. Lloyd, W. U. Jackson, and H. Hatton, London.
25,268. AUTOMATIC WEIGHING MACHINES, G. F. W. Schultze, London.
25,269. APPARATUS for MIXING MATERIALS, A. E. Hodder and G. Payne, London.
25,270. ELECTRIC GAS LIGHTERS, H. Baader and E. Rau, London.
25,271. RENDERING SURFACES CONDUCTING in ELECTROTYPING, H. J. Sheldon, Harrow.
25,272. SLIDING WINDOWS for CARRIAGES, F. D. Bird, Stanmore, Middlesex.
25,273. REGULATING the TEMPERATURE of ROOMS, C. E. Anderson, London.
25,274. CORSET ATTACHMENTS, D. Kops, London.
25,275. TOY for ADVERTISING PURPOSES, J. Sharp, London.
25,276. MANUFACTURE of RACKETS and BATS, F. Bryan, London.
25,277. EQUILIBRIUM SLIDE VALVES, W. Kruntschak, London.
25,278. SUBWAYS, M. W. Smith, London.
25,279. PRINTING MACHINES, H. H. Lake.—(*C. E. Cottrell and Sons Company, United States.*)
25,280. ADDRESSING ATTACHMENTS, J. P. Bryan, London.
25,281. ATMOSPHERIC GAS BURNERS, F. B. Passmore, London.
25,282. GENERATION of ELECTRIC CURRENTS, F. E. Elmore.—(*J. O. S. Elmore, India.*)
25,283. AUTOMATIC COUPLINGS, J. Willison, London.
25,284. TEACHING DRAWING from MODELS, J. T. Needham, London.
25,285. DOMESTIC FIRE-GUARD, J. Cuthill, London.
25,286. PLOUGH, B. S. Nunn, London.
25,287. MILLING MACHINE, F. E. V. Baines, London.
25,288. COUPLINGS, W. Radermacher and H. J. Etherington, London.
25,289. FIRE-ARMS, J. Gaut, London.
25,290. STEAM GENERATORS, J. A. Cox and A. M. Chance, London.
25,291. GEAR-CUTTING MACHINES, J. Anderson, London.
25,292. VALVES of ENGINES, K. J. and J. A. McMullen, London.
25,293. DEVICE for PICKING UP BALLS, T. G. Fulkes, London.
25,294. SECURING PIVOT to GUN AXLE, G. Ehrhardt, London.
25,295. PRESERVATION of EGGS, A. F. S. Kent and W. G. Barnfield, London.
25,296. VALVES, H. Berg, London.
25,297. INTERMITTENT ROTARY MOTION, A. Myall, London.
25,298. PUMP, W. P. Thompson.—(*G. Streri, Italy.*)
25,299. UTILISATION of CHLORIDE of CALCIUM, J. Jeffreys, Liverpool.
25,300. ROOFINGS, S. Haussen, Liverpool.
25,301. CADDIES, E. E. Roberts, Liverpool.
25,302. ROTARY CUTTING TOOLS, W. P. Thompson.—(*F. D. Chambers, United States.*)
25,303. CUTTING TOOLS, F. D. Chambers, Liverpool.
25,304. STRENGTHENED BETON FLOORINGS, W. P. Thompson. — (*The Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg, A.G., Germany.*)
25,305. MACHINE FEED MECHANISM, F. W. Vickery, London.
25,306. RAISING LIQUIDS by means of STEAM, A. Scholl, London.
25,307. ROLLING MILLS, R. Mengelbier, London.
25,308. MOWING MACHINES, N. P. Junkowski, London.
25,309. CYCLES, C. S. Ware, London.
25,310. ASCERTAINING the LEVEL of LIQUIDS, C. May, London.
25,311. INDICATORS for CALLING CABS, C. T. Austin, London.
25,312. INTERNAL COMBUSTION ENGINES, W. Langdon-Davies and A. Soames, London.
25,313. AIRSHIPS, A. J. Boult.—(*P. Livrelli and H. Myart, France.*)
25,314. LOCKS for RAILWAY CARRIAGE DOORS, T. W. Wilkes, London.
25,315. INCANDESCENT ELECTRIC LAMP HOLDERS, W. Defries and V. I. Feeny, London.
25,316. TILE for FLOORS, G. H. Bennett, London.
25,317. MOTOR-DRIVEN CYCLES, R. T. Monk, London.
25,318. ELECTRICITY METERS, W. E. Evans.—(*The Allgemeine Elektricitäts-gesellschaft, Germany.*)
25,319. CHECKING the SHOCKS upon HORSES in PULLING LOADED VEHICLES, O. Burberg and F. Mühler, Germany.
25,320. WRENCHES, E. Fischer, Germany.
25,321. BORING APPARATUS, J. Löwenstein, Germany.

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25,322. TEETOTUMS, A. E. Laing, Leeds.
25,323. PREPAYMENT GAS METERS, H. O'Connor, Edinburgh.
25,324. COMPOUND STEAM ENGINES, F., G., and R. Goodfellow, Manchester.
25,325. KNEE COVERINGS, J. Mathias, Liverpool.
25,326. GAME TABLES, J. H. Howell, Liverpool.
25,327. ACTUATING BRAKES of CYCLES, A. B. Stewart, Glasgow.
25,328. KEEPING the SEATS of TRAMCARS DRY, A. Batt, Glasgow.
25,329. ADJUSTING HEIGHT of SEATS, A. O. Windsor, Birmingham.
25,330. PRESS MECHANISM, F., L., and A. Sweeney, Birmingham.
25,331. PORTABLE VAPOUR BATH CABINETS, H. Frood, Manchester.
25,332. INTERNAL COMBUSTION MOTORS, H. G. Hills, Manchester.
25,333. BRACKETS for BICYCLE LAMPS, A. Paquier, Manchester.
25,334. MINERS' SAFETY LAMPS, L. N. Williams, Bristol.
25,335. SECURING BOTTLE STOPPERS, W. Brook, Stairfoot.
25,336 MINERS' COAL BORING MACHINES, G. S. Waterfall, Sheffield.
25,337. CUFF HOLDER, E. Bunce, Bradford.
25,338. BLEACHING FABRICS, J. W. W. Shaw, Bradford.
25,339. INCANDESCENT OIL GAS BURNERS, D. W. Hood, London.
25,340. DRIVING GEAR for BICYCLES, A. L. Baylay, Birmingham.
25,341. WASHING APPARATUS, L. E. Barbe, Liverpool.
25,342. PREVENTING RATTLING of DOORS, J. Eshelby, Liverpool.
25,343. SLATE-DRESSING MACHINE, F. E. Rooper, Liverpool.
25,344. LUNCHEON BASKETS, &c., F. Audinwood, Bradford.
25,345. VALVES for HYDRANTS, F. Greenwood and S. Lee, Liverpool.
25,346. MOISTENING GUMMED SURFACES, R. M. Champion, Liverpool.
25,347. MASSAGE APPLIANCE, J. T. Schillberg, Glasgow.
25,348. AUTOMATIC EXPANSION GEAR, J. G. Barclay, Glasgow.
25,349. TAP for WATER SUPPLY, J. Shanks and R. Burnside, Glasgow.
25,350. STOPPERING DEVICE for BOTTLES, G. Gunner, London.
25,351. WOOD-WORKING MACHINERY, J. W. Wadkin, Leicester.
25,352. MACHINE for MAKING LOCKNUTS, P. J. Wilson, Sheffield.
25,353. GAS NIPPLES for BUNSEN BURNERS, J. Moeller, London.
25,354. FIXING TILES to WALLS, W. Thomson and J Tuohey, Newcastle-on-Tyne.
25,355. SPINDLE for SPINNING MACHINES, C. W. Jones, Manchester.
25,356. WIND WHEEL, A. Schnabel, Berlin.
25,357. BRACER and TOE LASTER, A. Timms, Northampton.
25,358. AUTOMATIC FIRE-PROTECTING SHUTTERS, T Ohno, Glasgow.
25,359. HAT BRIM TRIMMER, C. A. Allison.—(*J. R. Griffeth and H. Morehouse, United States.*)
25,360. VALVE MECHANISM for ENGINES, A. W. and Z. Daw, London.
25,361. PISTONS for STEAM ENGINES, D. Mathieson, Glasgow.
25,362. APPARATUS for PROPELLING VESSELS, G. Wilson, London.
25,363. LEVER ADJUSTMENT, G. H. Lambert, Thornton Heath, Surrey.
25,364. MANGLING MACHINES, W. R. Laycock, Sheffield.
25,365. MEANS for EXTRACTING ALOE, D. R. Choksey, Manchester.
25,366. PREPARING FIBROUS MATERIALS, T. A. Boyd and J. and T. Boyd, Limited, Shettleston, Lanarkshire.
25,367. MANUFACTURE of TUBULAR COILS, J. G Reid, London.
25,368. GYRATORY CRUSHING MACHINE, H. Walker, London.
25,369. RANGE-KEEPING TELESCOPIC GUNSIGHT, T. Y. Baker, London.
25,370. EDUCATIONAL APPLIANCES, C. R. King, London.
25,371. BATTLEDOOR, J. R. Mally, London.
25,372. DRIVING GEAR for CYCLES, J. B. Forster, London.
25,373. STENCIL PRINTING APPARATUS, D. Gestetter, London.
25,374. ELECTRIC TIMEPIECES, &c., R. M. Lowne, London.
25,375. NON-REFILLABLE BOTTLES, E. De Fass.—(*S. Love, H. L. Maynard and T. J. Wool, United States.*)
25,376. CENTRIFUGAL MACHINES, F. A. Woolley, London.
25,377. PRESSES for TROUSERS, F. W. Osterman, London.
25,378. HOLDALLS, I. M. King, London.
25,379. STRAP ATTACHMENT for BAGS, I. M. King, London.
25,380. ATTACHING LIGHT SHADES to SUPPORTS, S. B. Marshall, London.
25,381. BOLTS for SECURING DOORS, W. Böcker, London.
25,382. TYPEWRITING MACHINES, J. C. Fell.—(*The Yost Writing Machine Company, United States.*)
25,383. RACKETS for TABLE TENNIS, H. E. Hughes, London.
25,384. ELECTRIC HAND LAMP, L. B. Miller, London.
25,385. PACKING HAIR NETS, R. White, London.
25,386. TIGHTENING WIRES, S. W. Bradbury, London.
25,387. ELECTRIC RAILWAYS, The British Thomson-Houston Company, Limited.—(*P. Farnsworth, United States.*)
25,388. ELECTRIC FUSES, The British Thomson-Houston Company, Limited.—(*H. Geiszhoner, United States.*)
25,389. ELECTRIC RAILWAYS, The British Thomson-Houston Company, Limited.—(*F. W. Hild and S. B. Stewart, jun., United States.*)
25,390. ELECTRIC RHEOSTATS, The British Thomson-Houston Company, Limited.—(*F. Mackintosh, United States.*)
25,391. BRAKING SYSTEMS, The British Thomson-Houston Company, Limited.—(*F. H. Case, United States.*)
25,392. PEAT DIGGING MACHINE, C. F. Schlickeysen, London.
25,393. COLOURING MATTERS, C. D. Abel.—(*Actiengesellschaft für Anilin Fabrikation, Germany.*)
25,394. REGULATING the PRESSURE of GAS, O. Imray.—(*E Coppée, Belgium.*)
25,395. MANUFCTURE of SODA, E. Geisenberger, London.
25,396. PERFORATING TELEGRAPHIC TAPE, F. G. Creed, London.
25,397. STEAM GENERATING PLANT, M. and S. Samuel, London.
25,398. ROLLER BEARINGS for CARPET SWEEPERS, T. H. Bedell, London.
25,399. AUTOMATIC WEIGHING APPARATUS, M. E. Reisert, London.
25,400. BOILERS for ASPHALT, A. J. Boult.—(*A. Baumann, France.*)
25,401. FOLDING TABLES, J. Jansen, London.
25,402. AUTOMATIC BRAKES, A. Bolzani, London.
25,403. ELECTRIC ENERGY METER, W. P. Thompson.—(*L. Decombe, France.*)
25,404. DYEING VESSELS, J. W. and J. H. Peet, London.
25,405. MINCING MACHINES, J. O. Spong, London.
25,406. SHEARS for HORSESHOES, W. E. Kimber, London.
25,407. COOKING APPLIANCE, J. C. Wegerif, London.
25,408. HAND-LEVER BRAKES for RAILWAY WAGONS, E. J. Hill, London.
25,409. BOTTLE STOPPERS, J. S. Alston, London.
25,410. MUD-GUARDS for VEHICLES, T. Cochrane, London.
25,411. STEAM TURBINES, J. Stumpf, London.
25,412. CONDENSERS for STEAM TURBINES, J. Stumpf, London.
25,413. CONDENSER for STEAM TURBINES, J. Stumpf, London.
25,414. GOVERNING DEVICE for STEAM TURBINES, J. Stumpf, London.
25,415. NON-SLIPPING STAIRCASES, A. Garstin, London.
25,416. MACHINE for ROLLING ARTICLES, H. N. Cahen, London.
25,417. MEASURING TAPES, A. L. Rutter, London.
25,418. ORDNANCE, W. L. Wise.—(*Skodawerke Actiengesellschaft, Austria.*)
25,419. HORSE COLLARS, R. Zielka, London.
25,420. OIL FILTER, T. Neuray, London.
25,421. AUTOMATIC FIRE-ALARM TRANSMISSION, G. B. Bowell, London.
25,422. DRAUGHT ARRANGEMENT for PLOUGHS, R. H. Fowler and W. Turner, London.
25,423. ENTRENCHING TOOLS, G. S. McDowell, London.
25,424. STEAM REGENERATIVE ACCUMULATORS, A. Rateau, London.
25,425. EXTRACTING OIL from FISH, F. V. Speltie, London.
25,426. CONTROLLING ELECTRIC CIRCUITS, S. Z de Ferranti, London.
25,427. SUPPORTS for TROLLEY and TRACK WIRES, H. M. Harding, London.
25,428. SPEED-INDICATING MECHANISM, J. W. Darley, jun., London.
25,429. STOPPERS for PREVENTING the REFILLING of BOTTLES, E. Crutchloe and S. Kemp, London.
25,430. STANDS for FOOT-POWER MACHINES, M. Slotkin and J. Praglin, London.
25,431. AUTOMATIC COUPLING for RAILWAY VEHICLES, W. Rohr, London.
25,432. PHOTOGRAPHIC ALBUMS, E. Osborne, London.
25,433. SPEED-REGULATING DEVICES, H. M. Harding, London.
25,434. SUSPENDING ELECTRIC LIGHTS, W. J. Chesterton, Birmingham.
25,435. MOTOR CAR, E. Vandenheede and A. Martin, London.
25,436. TROUSERS STRETCHER, G. C. Lidstone, Swansea.
25,437. VENTING CASKS and BARRELS, J. Mason, Malvern.

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25,438. GOVERNING INTERNAL COMBUSTION MOTORS, J. W. Newall, London.
25,439. TOY ANIMALS, C. Pomilio, London.

25,440. ENVELOPE and OPENER COMBINATION, W. Ward, London.
25,441. AUTOMATIC FIRE EXTINGUISHERS, O. Hoffmann, Manchester.
25,442. COOLING WATER, J. T. Pearson, Burnley.
25,443. ADVERTISING, W. M. Eckersley, Manchester.
25,444. RECOVERY of ARSENIC, J. E. Riley and J. Barnes, Manchester.
25,445. WHEEL RIMS and TIRES, M. Dawson, Liverpool.
25,446. RETARDING the BACK-RUNNING of TRAMCARS, C. H. Spencer, Bradford.
25,447. MOTORS, P. R. de F. d'Humy and R. J. Urquhart, Liverpool.
25,448 SECURING CORKS to BOTTLES, J. W. Maddison, Wakefield.
25,449. WELDING SHEET MATERIALS into PIPES, W. Love, London.
25,450. CLEANING GUN BARRELS. A. C Drummond and T. W. Laymon, Kingston-on-Thames.
25,451. OINTMENT for RELIEF of TOOTHACHE, C. H. H. Gore, Swindon.
25,452. BEE APPLIANCES, W. J. Sheppard and J. H. Howard, Peterborough.
25,453. AUTOMATIC WATER TANK, J. Williams, Llantrisant, Glamorgan.
25,454. STEAM GENERATORS, S. M. Cockburn, London.
25,455. PREPARATION for HOT and TIRED FEET, E. C. Cox, London.
25,456. WINDOWS, J. Procter, Shipley, Yorks.
25,457 CONDENSATION of VAPOUR, J. Hargreaves, Farnworth-in-Widnes.
25,458. CURRENT-CONVERTING APPARATUS, G. B. Batten, London.
25,459. VEHICLE STEERING GEAR, J. and J. Field, Penrith, Cumberland.
25,460. "FLASKS" for CASTING METALS, J. Rowley, Manchester.
25,461. HOOKS AND EYES, A. W. White, Manchester.
25,462. CONVERTIBLE TREAD for VEHICLES, F. Wilkins, Southsea.
25,463. FEEDING-BOTTLE HOLDER, C. Ashford, Birmingham.
25,464 MAGNETISING WATCHES, W. Routledge, Blaydon-on-Tyne.
25,465. PERAMBULATOR HOOKS, C. Ashford, Birmingham.
25,466. DETERMINING SHIPS' MAGNETISM, G. Hookham, London.
25,467. JOINT CONNECTIONS for BELTS, M. Foggarty, Manchester.
25,468. ANIMAL TRAPS, H. Meyer and C. Niemann, Berlin.
25,469. FRACTIONAL DISTILLATION APPARATUS, J. H. Müller, London.
25,470. MACHINERY for WASHING SAND, J. Clarkson, Glasgow.
25,471. COUPLINGS, J. C. Potts, O. H. Hemming, and G. W. Robertson, Glasgow.
25,472. BENDING MACHINES, H. O. Bennie, Cardonald, near Glasgow.
25,473 THROTTLE and RELEASE VALVES, W. Boby, London.
25,474. LAMPS, F. R. Hill and T. Hamilton-Adams, London.
25,475. CHUCK, T. Kay.—(*J. Kay and C. T. Wearne, Canada.*)
25,476. MANUFACTURING STEEL, W. B. Johnson.—(*N. McConnell, United States.*)
25,477 AUTOMATIC COUPLINGS, J. J. Smith. London.
25,478. AUTOMATIC RAILWAY POINTS, C. F. Simpson, Plaistow, Essex.
25,479. VENDING MACHINES, E. Shaw, London.
25,480. PLANING MACHINES, E. Andrew and A. W. Metcalfe, Belfast.
25,481. REGISTERING DEVICE in SCALES, C. A. Carlson, London.
25,482. CONVERTIBLE BEDSTEADS, E. K. Menzies, West Ferry, Forfarshire.
25,483. BRAKES for VELOCIPEDES, Rudge-Whitworth, Limited, and J. V. Pugh, London.
25,484. DEVICE for STARTING HORSE RACES, C. A. Chapman, London.
25,485. DEVICE for PLAYING PING PONG, J. Cutler, London.
25,486. BOTTLE OPENER, W. Boden, Sheffield.
25,487. APPLIANCE for CLEANING BOOTS, J. J. Eckert, London.
25,488. HYDROCARBON INCANDESCENT LAMPS, E. A. Boivin, London.
25,489. ORE-CRUSHING MACHINES, H. J. Scott, London.
25,490 ELECTRIC ARC LAMPS, T. Hamilton-Adams, London.
25,491. ELECTRICAL STARTING RESISTANCES, R. Waygood and Co., Limited, and H. C. Walker, London.
25,492. MEANS for STEERING SHIPS, H. A. Sawyer, London.
25,493 EXTRACTING TAR from GAS, E. D. Holmes.—(*O. N. Guldin, United States.*)
25,494. GAS PURIFIERS, E. D. Holmes.—(*O. N. Guldin, United States*)
25,495. LIDS for GAS RETORTS, E. D. Holmes.—(*O. N. Guldin, United States.*)
25,496. TELAUTOGRAPHS, F. Ritchie, London.
25,497. MANUFACTURE of LINCRUSTA, &c., F. Walton, London.
25,498. MANUFACTURE of VENEER RODS, H. H. Lake.—(*G. Sandberg, Germany.*)
25,499. WARP-STOP MOTIONS for LOOMS, J. V. and E. Cunniff, London.
25,500. COLLAR-FOLDING MACHINE, H. H. Lake.—(*W. Beattie and Son, United States.*)
25,501. TEETHING PADS, F. W. Ingram and J. C. W. Rofe, London.
25,502. CLOTHES HOLDERS, A. J. Boult.—(*A. Dieck, France*)
25,503. TABLE TENNIS RACQUETS, J. A. Baker, London.
25,504. TABLE TENNIS RACQUETS, A. Barnes and H. Luff, London.
25,505. MANUFACTURE of TILES, R Stanley, London.
25,506. COATS, A. M. Burberry, London.
25,507. SUPPORTING TWO-WHEELED VEHICLES, R. S. Williams and J. R. Handyside, London.
25,508. TICKETS, W. H. Sanders, London.
25,509. BOOK-STITCHING MACHINES, W. L. Wise.—(*The Actiengesellschaft vormals F. Martini and Co., Switzerland.*)
25,510. DEVICES for FASTENING CUFFS, E. Apperley, London.
25,511. SHAPING or BLOCKING BOOTS, R. Benz. London.
25,512. ARTIFICIAL STONE MANUFACTURE, E. Rott, London.
25,513. CORKING and SEALING BOTTLES, H. S. Page, London.
25,514. VOTE-RECORDING APPARATUS, W. Lake, London.
25,515. ADJUSTABLE DOOR HINGE, A. Christensson, Stockholm.
25,516. GENERATION of ACETYLENE, W. P. Warren, London.
25,517. SECURING TIRE COVERS, W. P. Thompson.—(*J. P. Le Grand, France.*)
25,518. PIPES, &c., W. P. Thompson.—(*C. Rudolph, France.*)
25,519. APPARATUS for CONSUMING SMOKE, O. Faller, Liverpool.
25,520. SAFES, C. Wallner, London.
25,521. GAS-DENSIFYING APPARATUS, A. Scholl, London.
25,522. PACKING LOOSE SUBSTANCES, F. T. Plester, London.
25,523. SLIDING HANDLE for STAIRCASES, F. Rüdiger, London.
25,524. CLIP or JOINT for CYCLES, W. R. Heighton, Limited, W. R. Heighton, G. Knighton, and H. Ball, London.
25,525. MANICURE OPERATIONS, F. Whit - Gould, London.
25,526. INCANDESCENT ELECTRIC LAMPS, H. Hogge and E. Pulsford, London.
25,527. SHOP COUNTERS, M. Greenfield, London.
25,528. BALL CASTORS, H. Peace, London.
25,529. ILLUMINATING DEVICE, A. Jarvis, London.
25,530. DETACHABLE CONDIMENT HOLDER, W. J. Charstone, London.
25,531. COMBINATION SMOKERS' DEVICE, G. B. Relph, London.
25,532. COMBINED OPAQUE TABLET, A. Smith and A. Browne, Glasgow.

14th December, 1901.

25,533. ILLUMINATIONS, W. J. Short, Birmingham.
25,534. WASHER, F. C. Whitfield, Manchester.
25,535. SPRING MATTRESSES, I. Chorlton and C. S. Lloyd, Manchester.
25,536. SECURING CORKS to BOTTLES, C. Parsons, Manchester.
25,537. CREMATORIUM FURNACES J. J. Meldrum and Meldrum Bros , Limited, Manchester.
25,538. DRAUGHT EXCLUDERS for DOORS, R. Taylor, Manchester.
25,539. MATCH-STRIKING SURFACES, S. Griffith, Birmingham.
25,540. PILLAR for SUPPORTING CABLES, A. W. Turner, Birmingham.
25,541. TYPEWRITING MACHINES, F. W. Shields and R. P. Link, Newcastle-on-Tyne.
25,542. AUTOMATICALLY REGULATING SUPPLIES of WATER, J. W. Martin, Nottingham.
25,543. APPARATUS for PURIFYING WATER, A. G. Brown, Bradford.
25,544. PAPER REELER BAR, G. E. Clegg, Manchester.
25,545. COILING WIRE, C. Edwards, A. V. Milton, and C. Holland, Manchester.
25,546. GARMENT-PRESSING APPARATUS, R. F. Jackson, Manchester.
25,547. CLOSING DENTAL VULCANISING FLASKS, W. P. Scott, Glasgow.
25,548. COMBINATION BOX, K. J. Bedingfeld, King's Lynn.
25,549. INDUCED DRAUGHT for FURNACES, L. Prat, Glasgow.
25,550. TRAMCAR BOGIES, A. S. Nelson, A. Stewart, and P. F. Foster, Glasgow.
25,551. BATH TRAP, P. Anderson, Edinburgh.
25,552. GAS COCK, G. H. McKay, Glasgow.
25,553. PROTECTING SOLES of BOOTS, W. C. Jackson Leeds.
25,554. PREVENTING TROLLEY WHEELS from LEAVING the WIRES in ELECTRIC TRACTION, M. F. T. Deane, Dublin.
25,555. MACHINE for SETTING BAND-SAWS, W. Challis, London.
25,556. The GRIP MONO RAIL SYSTEM, R. J. Baldrey, London.
25,557. EXHAUST STEAM GREASE SEPARATORS, S. W. Baynes, London.
25,558. GAS CONDUIT, R. W. Pollard and J. L. Davis, Brighton.
25,559. STOPPERING BOTTLES, A. E. Mitton, Birmingham.
95,560. ELECTRIC MOTOR CONTROLLER, A. J. Boult.—(*W. J. Richards, United States*)
25,561. VARIABLE SPEED MECHANISM, A. Herbert and P. V. Vernon, London.
25,562. MOTOR PLOUGH, E. Maxwell, London.
25,563. APPARATUS for PRINTING LABELS, T. Hawkins, London.
25,564. MONEY BELTS, B. Cope and B. Cope and Sons, Limited, London.
25,565. GAS REGULATORS, A. B. Cuff.—(*J. C. Cuff, Singapore.*)
25,566. ACETYLENE GAS MACHINE, J. W. Mackenzie.—(*E. S. Titus, United States.*)
25,567. NETS for TABLE TENNIS, E. J. Durham, London.
25,568. MEANS for SEALING JUGS, A. Reynolds, London.
25,569. TRAWL NETS, W. McCann, London.
25,570. LAUNCHING SHIPS' BOATS, H. R. Mortell, London.
25,571. SPEED INDICATOR, T. W. Flory and C. P. Reingpach, Colchester.
25,572. LASTING MACHINE, C. A. Harvey and S. R. Graves, London.
25,573. STEERING MOTOR VEHICLES, E. J. Rault, London.
25,574. RAISING LIQUIDS from DEEP WELLS, R. Stirling, London.
25,575. BAGGING POTATOES, J. Forshaw, Liverpool.
25,576. CATCHES for SLIDING WINDOWS, S. E. Dickinson, Liverpool.
25,577. HOOK-NEEDLES, F. B. Reuther, Liverpool.
25,578. MACHINERY for FUEL, J. H. Darby and A. J. Stevens, Liverpool.
25,579. MOWING MACHINES, D. Hughes, Liverpool.
25,580. TROLLEY STANDARDS, A. K. Baylor, London.
25,581. SURFACE CONDENSERS, J. R. Richmond, London.
25,582. STEAM SURFACE CONDENSERS, J. R. Richmond, London.
25,583. HAND FEED ELECTRIC ARC LAMPS, E. S. Shepherd, London.
25,584. HYDROCARBON MOTORS, F. Dürr. London.
25,585. SIGHTS for ORDNANCE, L K. Scott, London.
25,586. LEATHER BELTS, E. F. Sargeant and B. T. Smith, London.
25,587. PREVENTING FIRE in KINEMATOGRAPHS, L. E. Granichstaedten, London.
25,588. LIGHTERS for LIGHTING CIGARS, J. H. McLean, London.
25,589. COVERING for FLOORS, G. E. Zschiedrisch, London.
25,590. INCANDESCENT GAS BURNERS, A. J. Boult.—(*J. Braunstein, Germany.*)
25,591. SHUTTLE CHANGING DEVICE, O. Cosserat, London.
25,592. WATER SUPPLY of GENERATORS, T. Clarkson, London.
25 593 TANKS for MOTOR VEHICLES, T. Clarkson, London.
25,594. ROUGH-ROUNDING and CHANNELLING MACHINES, A. J. Boult.—(*United Shoe Machinery Company, United States.*)
25,595. MEANS for EFFECTING LOCOMOTION, F. E. Blaisdell, London.
25,596. FURNACES, C. I. Rader and E. E. Smeeth, Liverpool.
25,597. MEANS for CONVEYING PERSONS, F. E. Blaisdell, London.
25,598. MIXING and KNEADING DOUGH, J. Lee, London.
25,599. MANUFACTURING COCOA SUBSTITUTES, J. Meinl, London.
25,600. FUSE DEVICES, A. T. Dawson and L. Silverman, London.
25,601. REGULATING SPEED of PRIME MOVERS, R. Bibard, London.
25 602. MACHINES for MIXING and KNEADING DOUGH, J. Lee, London.
25,603. BLINDS, SHUTTERS, SCREENS, &c., H. Straker, London.
25,604. APPARATUS for PURIFYING GAS, G. J. Snelus, London.
25,605. MILLS, R. A. Hadfield and A. G. M. Jack, London.
25,606. FILTERS, C. E. Chamberland, London.
25,607. CONTROLLING SPEED of MACHINES, A. Roditi, London.
25,608. PREPARING COLOURS for PRINTING, P. Jochum, London.
25,609. CANISTERS, D. Cook and T. L. Spencer, London.
25,610. DEVICE for USE for ADVERTISING, G. Davis, London.
25,611. COIN-FREED METER MECHANISM, W. O. Green, London.
25,612. RECEPTACLE for HOLDING FLUIDS, H. T. Stephens, London.
25,613. MEASURING INSTRUMENTS, F. W. Schneider and A. Strauss-Collin, London.
25,614. THERMOSTATIC INDICATORS, O. Rennert, London.
25,615. CALENDARS or DATE INDICATORS, R. Grant, London.
25,616. MANUFACTURING PEAT BRIQUETTES, E. Helbing, London.

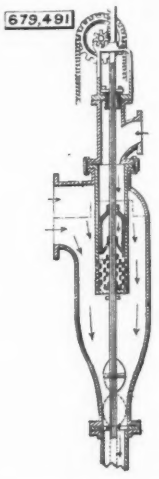
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

679,491. CONDENSER, *H. D. Baragwanath, Chicago, Ill.—Filed June 25th*, 1900.

Claim.—(1) In a condenser, the combination with the condensing chamber having water supply and discharge ports above and below said chamber, and a steam inlet port opening into said chamber, of a stationary valve chamber within said condensing chamber connected with the water supply port and opening into the condensing chamber between the exhaust steam inlet and the discharge port, said valve chamber having a number of circumferential series of valve-controlled ports leading therefrom into the exhaust chamber, substantially as described. (2) In a syphon condenser, the combination with the condensing chamber having water supply and discharge

679,491



ports above and below the same and a steam inlet opening therein, of a cylindric valve chamber connecting with the inlet port and extending into the condensing chamber to a point between the steam inlet port and the discharge port, a number of circumferential series of ports in the sides of said valve cylinder near the lower end thereof, a cylindric trunk valve working in said cylinder and adapted to successively close the series of ports therein, a valve working in the lower contracted end of the condensing chamber adjacent to the discharge port, a valve rod upon which both the supply and discharge valves are rigidly mounted, and means for reciprocating said rod, substantially as described.

679,483. TUBE-CUTTER, *L. W. Siple, Cherokee, Iowa.—Filed December 13th*, 1900.

Claim.—(1) The combination with a mandrel formed with a cylindrical longitudinal chamber, and with a transverse slot extending through the wall of the chamber, of a stem rotatable in said chamber, a stop on the stem extending in the slot, a radially-movable knife, and operative connections between the stem and the knife. (2) The combination of a mandrel formed with a longitudinal chamber and with a transverse slot extending through the wall of the chamber, a radially-movable knife block mounted in the mandrel. a rocking member detachably engaging the knife block. a rotatable stem mounted in the chamber and detachably engaging the rocking mem-

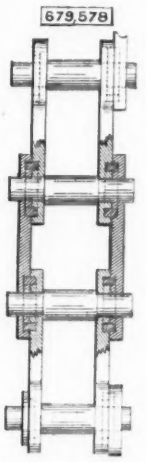
679,483

ber, and a removable stop pin carried by the stem and engaging in the slot; whereby said pin serves the double function of a stop and as a means for holding the parts in operative relations. (3) In a tube cutter the combination with a mandrel provided with a chamber, of a radially-movable knife, a rotatable operating stem mounted in the chamber, a transmitting member engaged by the stem and engaging the knife, and an encircling ring adjustably mounted on said member and form d to fit within the chamber, said ring forming the fulcrum on which the member rocks.

679,578. DRIVE CHAIN, *L. Schildknecht, Astoria, N.Y.—Filed May 6th* 1901.

Claim.—A drive chain comprising similar links in alternate and intermediate pairs with eyes at their

679,578

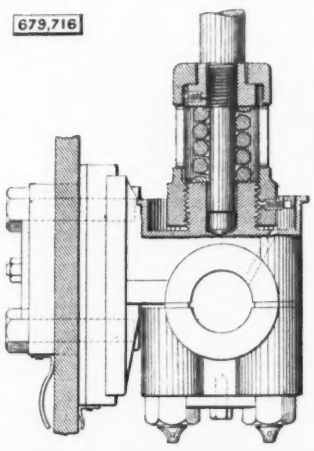


ends and pivot pins for holding the pairs of links together and rings between the opposing faces at the ends of the links fitting grooves in the links and upon which rings the links turn, substantially as set forth.

679,716. COMPRESSOR and PUMP, *A. G. Enock, Willesden, England.—Filed January 18th*, 1901.

Claim.—(1) In pumps and compressors, the combination of a crosshead and piston-rod, a projection on the crosshead having a socket into which the end of the piston-rod fits, a collar mounted on the piston-rod, a spring embracing the piston-rod and confined between the collar and projection, a cage secured on the projection and surrounding the spring, and an inwardly-projecting flange on the cage adapted to

679,716



engage the collar, substantially as described. (2) In refrigerating compressors the combination of a crosshead 3, a cage 4 carried by said crosshead and provided with slots 11, a spring 5 contained in said cage and always subjected to the normal temperature of the engine-room, a collar 8 on the piston-rod adapted to bear against said spring and to receive the thrust of the crosshead during the working stroke, and a flange 12 on the cage adapted to engage with the collar 8 during the return stroke, substantially as described.

END OF VOL. XCII

The Engineer.

Registered as a Newspaper

OFFICE FOR ADVERTISEMENTS AND PUBLICATION, 33, NORFOLK STREET, STRAND, W.C.

VOL. XCII.—No. 2400] LONDON: FRIDAY EVENING, DECEMBER 27, 1901. [PRICE { WITH SUPPLEMENT } SIXPENCE

Engineer Students in the NAVY

(16½ — 16¾). — FORTHCOMING EXAMINATION, 15th February, 1902.

The date specified is the latest at which applications can be received.

They must be made on forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. 2137a

NOTICE TO PRINTERS' ENGINEERS AND OTHERS.

The Director-General,

Ordnance Survey, is prepared to receive APPLICATIONS from firms willing to TENDER for the SUPPLY and ERECTION of FOUR HAND and POWER LITHOGRAPHIC PRINTING PRESSES, with FOUR CAST IRON BEDS.

Applications for forms of Tender, &c., should be made to the Officer in Charge of Stores, Ordnance Survey Office, Southampton.

All Tenders must be submitted before noon on the 15th January, 1902. 2126

India-office, Whitehall,
23rd December, 1901.

The Secretary of State for

India in Council is prepared to receive TENDERS from such persons as may be willing to SUPPLY—

STEEL RAILS, 75 lb. per yard.
STEEL FISH-PLATES.
FISH-BOLTS and NUTS.
W.I. SPIKES.
SWITCHES and CROSSINGS.

The conditions of contract may be obtained on application to the Director-General of Stores, India-office, Whitehall, S.W., and Tenders are to be delivered at that office by Two o'clock p.m. on Tuesday, the 7th January, 1902, after which time no Tender will be received.

E. GRANT BURLS,
Director-General of Stores.
2153

King's College, London.

(UNIVERSITY OF LONDON)

ENGINEERING, ARCHITECTURE, AND APPLIED SCIENCE DIVISION OF THE FACULTY OF SCIENCE.

LENT TERM COMMENCES THURSDAY, JANUARY 16TH.

PROFESSORS:—
MECHANICAL ENGINEERING—DAVID S. CAPPER, M.A., M. Inst. C.E., M.I.M.E.
CIVIL ENGINEERING—HENRY ROBINSON, M. Inst. C.E.
ELECTRICAL ENGINEERING—E. WILSON, M.I.E.E.
NATURAL PHILOSOPHY—W. G. ADAMS, M.A., D.Sc., F.R.S.
ARCHITECTURE—R. ELSEY SMITH, A.R.I.B.A.
CHEMISTRY—J. M. THOMSON, F.R.S., F.I.C.
MATHEMATICS—W. H. H. HUDSON, M.A.
METALLURGY—A. K. HUNTINGTON, A.R.S.M., M.I.M.E.
GEOLOGY and MINERALOGY—H. G. SEELEY, F.R.S.

EVENING CLASSES

are held for Civil, Mechanical, and Electrical Engineering, Workshop Practice, Architecture and Building Construction, Drawing, Metallurgy, Wood Carving, Mathematics, Physics, and all Science Subjects.

For prospectuses and all information apply to the SECRETARY, King's College, Strand, W.C. Y2141a

The Owens College, Manchester.

WHITWORTH ENGINEERING LABORATORY.

A COURSE of TEN DEMONSTRATIONS on the Strength of Materials and the Use of the Testing Machine, and a COURSE of TEN TRIALS, including Compound and Single (condensing and non-condensing) Engine Trials, Centrifugal Pump and Turbine Trials, will COMMENCE on FRIDAY, JANUARY 10th, at 6.30 p.m.

Fee for either course, £1 1s.

2122 S. CHAFFERS, Registrar.

The School Board for London

require additional MANUAL TRAINING INSTRUCTORS and ASSISTANT INSTRUCTORS in WOODWORK for the instruction of scholars in the day schools of the Board.

The scale of salaries is as follows:—Instructors, minimum £100 per annum, annual increase £5, maximum £155. Assistant instructors, minimum £80 per annum, annual increase £5, maximum £100.

All Instructors and Assistant Instructors will be required to have passed in the first class in Science Subject No. 1 of the Board of Education, South Kensington (practical, plane, and solid geometry), and to have obtained the full D certificate, or an equivalent thereof, namely, Science Subject No. 2 (machine construction and drawing), or Science Subject No. 3 (building construction), or a certificate in some kindred subject from the City and Guilds of London Institute.

If any persons are appointed who have not these qualifications, they will be required to obtain them, and will not be allowed any increase of salary until they have obtained them.

A certificate of competency to teach woodwork will also be required (the certificate of the City and Guilds of London Institute or a certificate in Sloid will be accepted).

The salary of Instructors and Assistant Instructors is for 27½ hours a week, some of which may be in the evening.

Instructors and Assistant Instructors may be required to teach woodwork for two additional evenings a week at 4s an evening of two hours' instruction.

No evening work other than that which may be provided by the Board is to be undertaken without the knowledge and consent of the School Management Committee.

Teachers in the service of the Board will be allowed to commence at their present salary, provided such salary be within the scale for Instructors.

The persons appointed will be required, if necessary, to attend classes for further instruction, as directed by the School Management Committee.

Applications must be made on a form to be obtained at the offices of the Board, and accompanied by copies of not more than three testimonials, must reach the Clerk of the Board, School Board for London, Victoria Embankment, not later than Thursday, 16th January, 1902, marked outside "M.T. Application S.M."

Persons applying through the post for forms of application must enclose a stamped and addressed envelope.

Candidates from the country invited to attend the Committee will be allowed third-class return railway fare to the London terminus.

In the case of candidates selected for appointment the fare will not be paid until after they shall have commenced work.

If a selected candidate should refuse to take up his appointment no travelling expenses will be allowed. 2127

Borough Council of St. Pancras.

—The Borough Council of St. Pancras are prepared to receive TENDERS for SUPPLYING:—

Section 1.—ENGINES, DYNAMOS, CONDENSERS, EXHAUST PIPES.
Section 2.—BOILERS, FEED PUMPS, STEAM and FEED WATER PIPES, &c.

Copies of specifications, conditions of contract, quantities, and form of Tender, to be obtained upon application at the Electricity Department Offices, No. 57, Pratt-street, N.W., on payment of a deposit of £2 for each section, which will be returnable only on receipt of a bonâ fide Tender and specification.

Tenders to be sent to the undersigned, endorsed "Tender for Section 1," "Tender for Section 2," by Twelve o'clock noon on Friday, 17th January, 1902.

The Council do not bind themselves to accept the lowest or any Tender.

C. H. F. BARRETT,
Town Clerk.

Town Hall, Pancras-road, London, N.W.,
23rd December, 1901. 2148

Warning.—To Makers and Users

OF POWER PRESSES OR LIKE MACHINES FOR DRAWING OR STAMPING METALLIC SEAMLESS HOLLOW-WARE.—TAYLOR and CHALLEN, Limited, of Birmingham, Engineers, WILL INSTITUTE IMMEDIATE LEGAL PROCEEDINGS AGAINST INFRINGERS (whether as makers or users) of any of their several patents relating to above.

SAUNDERS, BRADBURY, & SAUNDERS,
37, Temple-row, Birmingham,
Y2724a Solicitors for Taylor and Challen, Limited.

Borough of Marlborough.

SEWERAGE AND SEWAGE DISPOSAL.
CONTRACT B.
EXTENSION OF TIME

The Town Council of the Borough of Marlborough is prepared to receive TENDERS for the providing and laying of about 25 yards of 12in. Cast Iron Inlet Sewer and the construction of Cast Iron Storage Tank, Screening Chamber, Engine House, and Pump Well, together with the duplicate Gas Engines and Pumps and all accessories; also for the construction of Septic Tanks in duplicate; eight Bacterial Filters, and laying out the necessary land for Filtration, together with all incidental works.

Drawings and specification may be seen at the office of the Town Clerk, Mr. E. Llewellyn Gwillim, at Marlborough, from Ten to Four o'clock each day, except Saturdays.

Copies of specification, quantities, and form of Tender may be obtained from the Engineers, Messrs. Fairbank and Son, C.E.'s 13, Lendal, York, on deposit of Three Guineas.

This sum will, after the Town Council shall have come to a decision upon the Tenders, but not before, be returned to the tenderer provided that he shall have sent in a bonâ fide Tender, and shall not have withdrawn the same, and shall have returned the documents lent to him for the purpose of making up his Tender.

Sealed Tenders, endorsed "Marlborough Sewerage and Sewage Disposal—Contract B," must be addressed to the Town Clerk, Marlborough, on or before the 22nd January, 1902.

The Town Council does not bind itself to accept the lowest or any Tender.

E. LLEWELLYN GWILLIM,
Town Clerk.

Marlborough, December 7th, 1901. 2165

Borough of Middlesbrough.

ELECTRICITY WORKS.

The Electric Lighting Committee of the Borough of Middlesbrough invite TENDERS from Manufacturers for the SUPPLY and ERECTION of the following PLANT for the Extension of their Electricity Works:—

SECTION A.—ENGINE-HOUSE PLANT.
One 300 kwt. High-speed Steam Dynamo and Accessories.
SECTION B.—SWITCHBOARD PANELS.
Panels and Instruments for dealing with the above plant and three new Feeders.
SECTION C.—CONDENSING APPARATUS AND PIPE-WORK.
Ejector Condenser for dealing with 8000 lb. of steam per hour.
Steam Exhaust and Feed Pipes.
SECTION D.—FEED PUMP AND ECONOMISER.
One Feed Pump.
Extension to existing Economiser.
The whole bound up in one specification.

Applicants must state for which Section or Sections they wish to Tender, in order that the requisite drawings may be forwarded to them.

Tenderers are at liberty to Tender for either Section, but not for part of a Section.

Specification, with terms and conditions and forms of Tenders, may be inspected at the offices of Mr. Robert Hammond, M. Inst. C.E., the Consulting Engineer to the Council, 64, Victoria-street, Westminster, London, S.W., and may be obtained there, on and after the 23rd day of December, on making a deposit of £5 5s., which sum will be refunded to bonâ fide Tenderers after the Tenders are adjudicated upon.

Extra copies of the specification may be obtained by bonâ fide Tenderers at a charge of five shillings per copy, which sum will not be refunded.

Tenders, sealed and marked "Tender for Electricity Works," must be addressed to me at the Town Hall, Middlesbrough, and be delivered on or before 4 p.m. on Tuesday, the 21st day of January, 1902.

Each Tender must contain the names of two sureties, who will be prepared to execute a joint and several bond for the due performance of the Contract in the sum of 10 per cent. of the Contract amount.

The Council do not bind themselves to accept the lowest or any Tender.

GEORGE BAINBRIDGE,
Town Clerk.

Middlesbrough,
December 16th, 1901. 2074

Corporation of London.—Con-

TRACT FOR WIDENING LONDON BRIDGE.

Notice is hereby given that the Bridge House Estates Committee of the Corporation of London will meet at the Guildhall on Monday, the 17th day of February, 1902, to receive TENDERS for the WIDENING of LONDON BRIDGE.

Drawings and specification may be seen at the office of the City Surveyor, Guildhall, on and after Wednesday, the 1st day of January, 1902, between the hours of 10 a.m. and 4 p.m.

Copies of the drawings, specification, form of Tender, contract and bond, and bill of quantities, may be obtained at the City Surveyor's Office, Guildhall, on loan, on deposit of Ten Pounds, which will be returned to all who send in a bonâ fide Tender and return all documents.

Tenders (which must be accompanied by the whole of the documents obtained on loan) must be on the printed form, which must not be detached from the specification, and must be sealed up and addressed to "The Bridge House Estates Committee, Guildhall," endorsed "Tender for the Widening of London Bridge," and left at the Hall-keeper's Office, Guildhall, London, E.C., before Twelve o'clock noon on Monday, the 17th day of February, 1902.

The Committee do not bind themselves to accept the lowest or any Tender.

MONCKTON.

Guildhall,
December 12th, 1901. 2132

Edinburgh and Leith Corpora-

TIONS' GAS COMMISSIONERS.
STEEL LATTICED GIRDER FOOTBRIDGE AND TRUSSED ROOFS.

The Commissioners are prepared to receive TENDERS for the CONSTRUCTION and ERECTION of a STEEL LATTICED GIRDER FOOTBRIDGE and TRUSSED ROOFS in connection with their new works at Granton.

Specification, schedule of quantities, and form of Tender, may be obtained on application to Mr. W. R. Herring, Chief Engineer and Manager, and drawings may be inspected at his Office, at the New-street Works, Edinburgh.

The Tender forms supplied must be filled in and signed by a principal or a declared agent of the parties tendering, and returned, undetached from the specification and schedule, and delivered to the undersigned at or before 10 a.m. on the 30th day of December, 1901, sealed and endorsed "Tender for Steel Latticed Girder Footbridge and Trussed Roofs."

The Commissioners do not bind themselves to accept the lowest or any offer, and reserve to themselves the right to allot the Contracts to one or more contractors.

JAMES M'G. JACK,
Clerk.

25, Waterloo-place, Edinburgh,
5th December, 1901. 2015

Johannesburg Municipality.—

MUNICIPAL NOTICE No. 97.
CARBURETTED WATER GAS PLANT.

TENDERS are invited for the SUPPLY and DELIVERY of a complete CARBURETTED WATER GAS PLANT of a capacity of about 200,000 cubic feet daily.

Specification, with general plan of present works, can be obtained on application from the Crown Agents for the Colonies, Downing-street, London, or from the Town Clerk, Johannesburg.

Tenders, in sealed envelopes, marked on outside "Tender for Carburetted Water Gas Plant," to be received by the Town Clerk, Johannesburg, on or before January 31st, 1902.

The lowest or any Tender not necessarily accepted.

(signed) LIONEL CURTIS,
Acting Town Clerk.

Johannesburg, 4th November 1901. 2091

County Borough of West Ham.

SEWAGE PUMPING PLANT FOR SALE.

The Council, having erected a new Pumping Station, invite TENDERS for the PURCHASE of the following PLANT at their old Pumping Station, Canning Town:—

ONE PAIR of HIGH-CLASS COMPOUND CONDENSING BEAM PUMPING ENGINES, by James Watt and Co., of Birmingham, 1890.
ONE PAIR of SINGLE CONDENSING BEAM PUMPING ENGINES, by Galloway, of Manchester, 1870.
ONE PAIR of GWYNNES CENTRIFUGAL PUMPS, 15in. diameter, complete.
TWO LANCASHIRE BOILERS, 30ft. by 7ft. 6in., and THREE LANCASHIRE BOILERS, 24ft. by 6ft., together with pumps, crane, fittings, &c.

Further particulars, with orders to view, may be obtained on application at the Borough Engineer's office, Town Hall, West Ham, E.

Tenders, endorsed "Tender for Sewage Pumping Plant," are to be sent to my office not later than 4 o'clock p.m., on Tuesday, 14th January, 1902.

The Council do not bind themselves to accept the highest or any Tender.

By order of the Council,
FRED. E. HILLEARY,
Town Clerk.

Town Hall, West Ham, E.,
12th December, 1901. 2065

North-Eastern Railway. — To

CONTRACTORS. — The Directors are prepared to receive TENDERS for the CONSTRUCTION of a RAILWAY from Gosforth to Ponteland, commencing by a junction with the Blyth and Tyne Railway, immediately north of Gosforth Station, and terminating in a field on the north side of Ponteland village. Plans, specifications, quantities, and indenture may be seen at the office of Mr. Charles A. Harrison, Central Station, Newcastle-upon-Tyne, on and after Monday, 16th December, where specifications, quantities, and forms of Tender may be obtained on personal application. Sealed Tenders, marked "Tender for Ponteland Light Railway," and addressed to the Secretary, must be delivered at his office in York not later than noon on Wednesday, 8th January, 1902. The Directors do not bind themselves to accept the lowest or any Tender, and ample security will be required from the Contractor whose Tender is accepted.

C. N. WILKINSON, Secretary.

York, 14th December, 1901. 2078

TO FOUNDERS AND HYDRAULIC ENGINEERS.

The Corporation of Royal Leam-

INGTON SPA invite TENDERS for the CONSTRUCTION and DELIVERY at Leamington Station of FIVE CAST IRON PENSTOCKS, each 6ft. by 4ft., to be operated by hand.

Specifications may be obtained from their Engineer, W. de Normanville, at the Town Hall, Leamington.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders to be sent to me on or before January 6th, duly endorsed.

LEO RAWLINSON,
Town Clerk.

Town Hall, Leamington,
December 24th, 1901. 2169

The Delhi, Umballa, Kalka Rail-

WAY COMPANY, LIMITED.
KALKA—SIMLA RAILWAY.
SWITCHES AND CROSSINGS.

The Delhi, Umballa, Kalka Railway Company, Limited, is prepared to receive TENDERS for the SUPPLY and DELIVERY of SWITCHES and CROSSINGS as per specification to be seen at the Company's offices.

Tenders are to be sent to the undersigned, marked "Tender for Switches and Crossings," not later than 12 o'clock noon on Friday, 3rd January, 1902.

The Company does not bind itself to accept the lowest or any Tender.

For each specification a fee of 10s. 6d. will be charged, which is not returnable.

By order,
W. M'FARLANE,
Secretary.

17, Victoria-street, Westminster, S.W.,
20th December, 1901. 2144

West Ham Union.—To Electric

LIGHTING CONTRACTORS.

The Guardians invite TENDERS for the SUPPLY, DELIVERY, and FIXING at their New Infirmary, Forest House, Leytonstone, N.E., of:—

Three Direct-coupled Engines and Dynamos and One Motor Booster, One Battery of Accumulators, all Engine and Battery Room Accessories, the whole of the Feeders, Distribution Mains, Junction-boxes, Main and Sub-distribution Boards, and all Wiring Fittings, Lamps, &c., for about 1756 C.P. lamps.

The drawings and specification, prepared by the Consulting Engineer, Mr. John Buley, of Suffolk House, Laurence Pountney-hill, London, E.C., may be inspected on and after the 6th January next at the Clerk's office at the Workhouse, between the hours of Ten and Four.

Forms, upon which Tenders must be made, can be obtained at the said office on payment of a £10 Bank of England note, which will be returned on receipt of a bonâ fide Tender, together with the return of any drawings or specifications that may have been supplied.

The firm whose Tender is accepted will be required to enter into a contract and a bond with two sureties for the proper carrying out of the work, and will be required to pay their workmen the trades union rate of wages current in the district.

Tenders, on the prescribed forms, must be delivered to the undersigned on or before the 22nd January, 1902.

The Guardians do not bind themselves to accept the lowest or any Tender.

By order of the Board,
FRED. E. HILLEARY,
Clerk to the Guardians.

Clerk's Office,
Union Workhouse, Leytonstone, N.E.,
23rd December, 1901. 2151

Willesden District Council.—To

STEAM ROLLER MANUFACTURERS.

The Willesden District Council are prepared to receive TENDERS for the SUPPLY of a 10-TON STEAM ROAD ROLLER and ROAD SCARIFIER, complete in every respect and ready for use, to be delivered at the Store-yard of the Council within fourteen days from order to supply same.

All particulars and form of Tender may be obtained on and after Friday, the 20th day of December, 1901, upon application to Mr. O. Claude Robson, M. Inst. C.E., Engineer to the Council, Public Offices, Dyne-road, Kilburn, N.W.

Tenders, endorsed "Steam Roller and Road Scarifier," to be delivered at the offices of the Council not later than 4 p.m. on Tuesday, January 7th, 1902.

A £10 note to be deposited with each Tender, which will be returned to unsuccessful contractors immediately Tenders are accepted, and to the successful contractor upon execution of contract and bond.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
STANLEY W. BALL,
Clerk to the Council.

Public Offices,
Dyne-road, Kilburn, N.W.,
December 16th, 1901. 2089

Wanted, Foreman Brassfinisher

in Manchester, accustomed to automatic machinery, division of labour, and cheap production of steam fittings and high-class brass work. Salary £4 per week. Non-society and abstainer preferred. State age and experience.—Address, 2152, Engineer Office, 33, Norfolk-street Strand, W.C. 2152

Harrington Pier Extension.—

WANTED, an experienced FOREMAN, capable of taking ENTIRE CHARGE of the above work.

The person to be appointed must be experienced in pile-driving, excavation below water level, and concrete block setting, &c.

Salary will be £5 per week for a six months' engagement.

Candidates must be between 35 and 50 years of age.

Applications, together with copies of recent testimonials, to be forwarded to the undersigned not later than 31st January next.

R. WHITE AND SONS,
Contractors.

Widnes. 2133

Metropolitan Borough of Poplar.

TO CONTRACTORS MANAGERS, ENGINEERS, &c.

The Council of the above-named Borough invite APPLICATIONS for the position of BOROUGH SURVEYOR and WORKS MANAGER at a salary of £500 per annum.

Candidates, in addition to possessing the ordinary qualifications of a Borough Surveyor, must be thoroughly practical men, and have had experience in the carrying out of extensive works, and in the organisation and management of a department similar to the Works Department of the Council, and be fully competent in every respect to undertake charge of that Department, including efficient direction and control of the staff and workmen attached thereto.

Applications, endorsed "Application for Appointment of Borough Surveyor and Works Manager," stating age and previous experience, and accompanied by copies of not more than three recent testimonials must reach the undersigned not later than Saturday, the 4th January, 1902.

Canvassing members or officers of the Council will disqualify.

LEONARD LOTH,
Town Clerk.

Council Offices,
High-street, Poplar, E.,
23rd December, 1902. 2145

Tyneside Electric Power Scheme.

The Company supplying electric power on Tyneside are prepared to receive APPLICATIONS for a limited number of JUNIOR ASSISTANTSHIPS.

Applicants must have spent three or four years in an engine works, and some knowledge of electrical theory is desirable.

Successful applicants will be required to sign an agreement to remain in the Company's service for a period of two years. During this time they will have an opportunity of seeing all or some portion of the work under the Company's control, which includes Polyphase and Continuous Current Systems, as applied to power distribution, lighting, and tramways.

Remuneration to commence 15s. per week, increasing by definite amount as the engagement proceeds.

Applications, stating age, training, and enclosing not more than one testimonial, to be addressed to 2135, Engineer Office, 33, Norfolk-street, Strand, W.C. 2135

Wanted, a Thorough Good

FOREMAN for small Engine Shop.—Apply in own handwriting, stating experience and wages required, to I. T. CRAMPTON, Shipyard, Portsmouth. P225

Wanted, an Engineer to Take

CHARGE of Steam Heating Apparatus and other Machinery.—Address, stating age, experience, and wages required, 2167, Engineer Office, 33, Norfolk-street, Strand, W.C. 2167

Wanted, an Experienced Tele-

GRAPH MANAGER for the Tropics, capable of taking full charge of a system of cables and land lines.—Apply by letter only, stating experience and salary expected, to A., care of Housekeeper, Moorgate Station-chambers, E.C. P215

Wanted, Chief Engineer, with

special knowledge of rolling plant, wire-drawing and galvanising plant. Duties to commence in February.—Testimonials and experience to SHROPSHIRE IRON COMPANY, Limited, Hadley, near Wellington, Salop. 2129

Wanted, First-class Mechanics

for outside Fixing and Starting of Oil Engines for Electric Lighting; those with a knowledge of electricity preferred.—Address, stating age and experience, 2138, Engineer Office, 33, Norfolk-street, Strand, W.C. 2138

Wanted, First-class Mechanics

for outside Fixing and Starting of Oil Engines for Pumping; those experienced in the latter class of work preferred.—Address, stating age and experience, 2139, Engineer Office, 33, Norfolk-street, Strand, W.C. 2139

Wanted, Good Draughtsman

accustomed to Crane work. Permanent situation and good salary to practical man.—State age, salary, and full particulars to THOMAS SMITH, Steam Crane Works, Rodley, near Leeds. 2110

Wanted, Good Draughtsman,

used to Bridge and Roof Work; must have good knowledge of strains, and be able to take out quantities.—Address, stating experience and salary required, 2143, Engineer Office, 33, Norfolk-street, Strand, W.C. 2143

Wanted, in London, a Draughts-

MAN, accustomed to cranes, elevators, lifts, and conveyors. State qualifications and salary.—Address, P213, Engineer Office, 33, Norfolk-street, Strand, W.C. P213

Wanted, in Yorkshire, a

DRAUGHTSMAN, used to General Engineering work.—Address, stating age, experience, and wage expected, to 2155, Engineer Office, 33, Norfolk-street, Strand, W.C. 2155

Wanted in Yorkshire, Draughts-

MAN, well versed in all classes of high-pressure steam valves.—Address stating experience and wage required. 2156, Engineer Office, 33, Norfolk-street, Strand, W.C. 2156

Wanted, in the Costs and Wages

Department of Large Steel Works in Yorkshire, a thoroughly efficient and practical HEAD ASSISTANT, who has had experience in a similar capacity. Applicants to state age, experience, and salary required.—Address, 2136, Engineer Office, 33, Norfolk-street, Strand, W.C. 2136

Wanted, Junior Draughtsman

for Patent Agent's Office. One experienced in such work preferred. State age, experience, salary required, &c.—Address, P217, Engineer Office, 33, Norfolk-street, Strand, W.C. P217

For Continuation of Situation Advertisements see page II.

For continuation of Small Advertisements see pages II., III., IV., *and* LXIV.

*** *Index to Advertisers on page* LXIII.

Wanted, Junior Draughtsman with Shop and Office Training. Preference given to one with experience in electrical cable accessories and switchboard work. State age and salary expected.—Address, 2134, Engineer Office, 33, Norfolk-street, Strand, W.C. 2134

Wanted, Smart, Active Im- PROVERS for Erecting Shop; good opportunity for steady young men.—State age and past experience to JAMES SIMPSON and CO., Limited, Lowfield Foundry, Newark-on-Trent. 2073

Wanted, 3 First-class Fitters and ERECTORS, preferably with good locomotive and stationary engine experience. None but first-class, sober, and energetic workmen need apply, giving age, past experience, and wages required. A good permanent situation offered to suitable men.—LOWCA ENGINEERING COMPANY, Ltd., Whitehaven. 2083

Appointments as Inspectors of WEIGHTS and MEASURES may be obtained by persons over 21 who will qualify for Board of Trade Exam. Salaries £100 to £350 a year.—Write for particulars to INSPECTOR of WEIGHTS and MEASURES, Oakham, Rutland. 11

Draughtsman (Junior) Wanted in Mechanical Factory, with a knowledge of constructional and general factory work.—Reply, stating experience and salary required, to H. T., 120, Oxford-street, W. 2150

Electric Light Engineer Wanted, for Private Station; he is to drive the Willans engines, take charge of switchboard and accumulators, direct the stoker, and be able to do small repairs and wiring.—Applications to be on forms obtainable from the SECRETARY, Goldsmiths Institute, New Cross, S.E. P218

Junior Draughtsman Wanted, with good all-round experience.—Apply, stating age, references, and salary required, to SUSSEX PORTLAND CEMENT COMPANY, Limited, Newhaven, Sussex. 2146

Messrs. Browett, Lindley and CO., Patricroft, near Manchester, REQUIRE the services of a first-class FOREMAN to take Entire Charge of their Erecting Department, the work consisting almost entirely of Enclosed Forced Lubrication Engines. Must be a six o'clock man, non-society, and have had good experience in similar position. A good salary will be paid to a competent man.—Apply in writing to the above firm. No personal application will be entertained. 2166

Shipbuilder ; Engineer.— WANTED, an OUTSIDE MANAGER for shipbuilding and repairing establishment on the Continent; also an ENGINEER-MANAGER to take charge of shops. Applicants to give full particulars of experience and qualifications, stating age and salary expected. All communications confidential.—Address, BETA 365, Messrs. Deacon's, Leadenhall-street, London. 2149

Wanted, an Appointment as DEPUTY or TRAFFIC MANAGER on any railway in Europe or elsewhere. Applicant has had many years' experience.—Particulars as to salary required and copies of testimonials will be forwarded on application to A. B., care of Messrs. H. S. King and Co., 45, Pall Mall, London. P154

Wanted, Situation as Draughts- MAN. Experience in tugs, launches, and engine work, chemical works. Salary 35s. per week.—Address, P222, Engineer Office, 33, Norfolk-street, Strand, W.C. P222

A Practical Engineer, Recently returned from Central America, with 25 years' experience in various kinds of engineering at home and abroad, is OPEN for another ENGAGEMENT as Chief Engineer of Works; first-class testimonials; conversant with Spanish.—Address, P219, Engineer Office, 33, Norfolk-street, Strand, W.C. P219

Contractors' Agent, with Con- SIDERABLE experience, is anxious to OBTAIN POST in either Australia, New Zealand, or South Africa, as CONTRACTORS' AGENT or COMPANY'S ENGINEER; high references as to ability and character.—Address, P167, Engineer Office, 33, Norfolk-street, Strand, W.C. P167

Foreman, Aged 29, Experienced in fitting, erecting, and machine shops, OPEN to ENGAGEMENT at end of year; first-class references.—Address, 2106, Engineer Office, 33, Norfolk-street, Strand, W.C. 2106

Young Mechanical Engineer (Swiss), who has been through the Technikum Winterthur, and has several years' practical experience, SEEKS ENGAGEMENT in Mechanical Works.—For reference and information, address, OF9233, Orell Fusli-Annoncen, Zurich, Switzerland. 2140

A Firm of Civil Engineers and Surveyors in the North of England, having large Water, Drainage, and Tramway schemes in hand, have an OPENING FOR A PUPIL.—Address, 2158, Engineer Office, 33, Norfolk-street, Strand, W.C. 2158

Engineering Pupil. — Firm (Government Contractors), employing 500 hands, have VACANCY; varied classes of work done, affording excellent opportunities; premium moderate.—Address, B415, Engineer Office, 33, Norfolk-street, Strand, W.C. B415

Engineer Wanted, having thorough knowledge of Oil Engines (or having a speciality, such as Motor Cars), for first-class Limited Company; must be able to introduce about £3000.—Address full particulars, 2097, Engineer Office, 33, Norfolk-street, Strand, W.C. 2097

Partnership.—Engineer, of Long experience in mechanical and electrical practice, best general and scientific education, large home and foreign connection, and speaking several languages, DESIRES ACTIVE PARTNERSHIP in well-established consulting or manufacturing firm; can supply moderate capital on good security.—Address, 2072, Engineer Office, 33, Norfolk-street, Strand, W.C. 2072

Important German Firm, Manu- FACTURING clay-working machinery, crushing machinery, &c., WANTS a REPRESENTATIVE with practical experience; engineering firms dealing in machinery preferred.—Apply, stating terms, Box 87, G. P. O., Sheffield. 2085

Wanted, a Commercial Gentle- MAN, with about £500, to JOIN a PRACTICAL MAN with a like amount for the purpose of manufacturing high-class American machine tools.—Address, P220, Engineer Office, 33, Norfolk-street, Strand, W.C. P220

Wanted, Commercial or Prac- TICAL MAN with capital in engineering and shipbuilding business. State experience and amount available.—Address, P181, Engineer Office, 33, Norfolk-street, Strand, W.C. P181

Wanted, a Second-hand, Return- TUBE MARINE BOILER; must be in first-class condition; about 180ft. of heating surface, suitable for a working pressure of 100 lb. per square inch. State price and full particulars.—Address, 2154, Engineer Office, 33, Norfolk-street, Strand, W.C. 2154

Wanted, a Second-hand Saw BENCH, to carry about 42in. Saw; must be in good condition and moderate price.—Apply, with full particulars, to W. TODD, Hartwell, Aylesbury. P216

Wanted, Heavy Second-hand Self-acting SLIDING and SCREW CUTTING LATHE, 24in. to 30in. centres, with gap bed. Also Single Standard STEAM HAMMER, 12in. to 16in. cylinders.—JOHN H. RIDDEL, 40, St. Enoch-square, Glasgow. 2157

Wanted, Second-hand, in First- CLASS WORKING ORDER.
7 cwt. Rigby type STEAM HAMMER, 11in. dia. cylinder × 20in. to 24in. stroke.
BENDING ROLLS, one top, two bottom, 9in. to 10in. dia. × 7ft. long, for light work.
PUNCHING MACHINE, ¾in. largest hole, 18in. gap, minimum.
RADIAL DRILLING MACHINE, arm 3ft. 6in. to 5ft. radius, largest hole 4in.
BAND COLD-SAWING MACHINE.
SCREWING MACHINE, 2in. largest. 2124
Address, 2124, Engineer Office, 33, Norfolk-street, Strand, W.C.

Wanted, Tandem Air Com- PRESSOR, about 9in. dia. cylinder by 15in. stroke.—WARDLE, Upper Eastville, Bristol. P224

Boilers.—We now have in Stock FORTY BOILERS, including some very superior Lancashire Boilers up to 30ft. by 7ft. 6in. and 28ft. by 8ft., for pressures up to 90 lb., to pass insurance company; low prices.—THOMAS MITCHELL and SONS, Limited, Bolton. 2113

Bright-Drawn Steel Bars, for use in Automatic Screw Machines and Turret Machinery. Large stocks of current sizes for immediate delivery at special Prices.—ALFRED HERBERT, Ltd., Coventry. 1

Cameron Type Steam Pumps.— NEW; in Stock; 3in. rams and 3in. rams. 1196
KAWLINSONS LTD., Pumping Engineers, Leeds.

Dredger.--For Sale or Hire, Strong BUCKET LADDER DREDGER, capable of raising 150 tons per hour from a depth of 18ft.—Address, Y2362a, Engineer Office, 33, Norfolk-street, Strand, W.C. Y2362a

Fly-wheels and Pulleys for DISPOSAL.—C.I. Belt Pulley, 16ft. 4in. dia., 36in. face, 12½ tons; W.I. Belt Pulley, 16ft. dia., 25in. face; Fly-wheels, 18ft., 15ft., 14, 12½, 12, 10, 9, 8, and 7ft. diam. Also 2000 belt and rope pulleys in stock.—THOMAS MITCHELL and SONS, Limited, Bolton. 2111

For Hire, Pumps and Well- BORING TOOLS for Contractors, Deep Wells, &c., 2in. to 24in. diam.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 976 Hop. 822

For Sale.—
Powerful HORI. COMPOUND MILL ENGINE, 27in. × 46in. cyls., 6ft. stroke.
VERTICAL REVERSING MILL ENGINE, 30in. inverted cyl., 4ft. stroke.
Pair 21in. HORIZONTAL TANDEM CONDENSING ENGINE.
25 N.H.P. COMP. S.C. ENGINE, 10in. × 16in. × 20in.
HORI. COMP. REFRIGERATING PLANT, steam cyls., 12in. and 20in. × 22in. stroke.
HIGH-PRESSURE HORI. ENGINE, 24½in. × 48in. stroke.
3 VERTICAL CHANDLER FAN ENGINES.
20, 12, 6, 4, and 2 H.P. Crossley GAS ENGINES.
200 I.H.P. VERTICAL COMP. Brush Electric Light ENGINE, with Mordey alternator.
Tangye Electric Light ENGINE and DYNAMO, 9in. cyl., 9in. stroke.
CORNISH BOILER, 20ft. × 5ft. 6in., for 80 lb. working pressures.
Do. do., 12ft. × 5ft., for 120 lb. working pressure.
LANCS. BOILER, 25ft. × 7ft. 6in., for 100 lb. working pressure
Send for free copy of the "Albion Machinery Catalogue" (new issue just out), contains upwards of 2000 lots actually in stock, suitable for Engineers, Ironworks, Collieries Contractors, &c
THOS. W. WARD,
ALBION WORKS, SHEFFIELD.
Telegraphic Address: "Forward, Sheffield.
London Depôt: SUGAR HOUSE-LANE, STRATFORD, E. 2101

For Sale, a 10 H.P. Steam NAVVY, No. 201, by Ruston, Proctor and Co.; done very little work; is equal to new.—For price, apply, CHAS. BAKER and SONS, South Wigston, Leicester. 2147

For Sale:—Compound, Vertical Inverted ENGINE, massive pattern, cylinders 12in. and 20in. by 20in. stroke.
Vertical Inverted high-pressure ENGINE, cylinder 12in. by 12in. stroke.
One Allen's Patent STEAM STRIKER.
STATIONARY RIVETER, new, 9ft. 6in. gap, all latest improvements, hydraulic Tweddell's system.
PUMPS and ACCUMULATOR for above, all new and ready for delivery.
GAS ENGINE, ½ to 16 H.P. nominal; good order.
FIELDING AND PLATT, LIMITED,
GLOUCESTER. Y1646

For Sale, Dynamo, Compound wound, 120 amps., 110 volts, 850 revs.; splendid order.—WALKER HILL and CO., Nottingham. 1943

For Sale, Horizontal Compound CONDENSING STEAM ENGINE, to drive 100 H.P. at 80 R.P.M. and 80 lb. working pressure; band fly-wheel.—H. J. H. KING and CO., Nailsworth. 2142

For Sale, in London, Nearly new 3-ton LOCO. CRANE, by leading makers, 7ft. gauge A bargain.—Address, 2128, Engineer Office, 33, Norfolk-street Strand, W.C. 2128

For Sale, New Steel Lancashire BOILERS, ready for immediate delivery:—Six 30ft. long by 8ft. dia., for 100 lb. working pressure; one 30ft. long by 8ft. dia., for 120 lb. working pressure; six 30ft. long by 8ft. 6in. dia., for 120 lb. working pressure.—SPURR, INMAN and CO., Ltd., Calder Vale Boiler Works, Wakefield. Y2639

For Sale or Hire:—
PORTABLE ENGINES, also HORIZONTAL, and VERTICAL ENGINES and BOILERS, 2 to 30 H.P.
LOCO. STEAM CRANES.
STEAM WINCHES, HOISTS, MORTAR MILLS.
SAW BENCHES, WOOD-WORKING MACHINERY
Every description of Contractors' Builders', and Saw Mill Plant, New and Second-hand.
Large Stock Shafting, Bearings, and Pulleys, &c.
E. HOUGHTON BROWN, M.I.M.E., Kingsbury Ironworks' Ballspond, London. C1
Telegraph, "Spherulite," London. Telephone No. 38, Dalston

For Sale or Hire.—
PORTABLE ENGINES, 6 to 30 N.H.P.
SEMI-PORTABLE ENGINES, 12 to 50 N.H.P.
TRACTION ENGINES, 5 to 10 N.H.P.
PLOUGHING ENGINES and Implements.
CENTRIFUGAL PUMPS.
SAW BENCHES and SAWS.
Immediate delivery from works for breakdowns, &c.
HENRY LEWIS AND SONS,
ENGINEERS, READING. Y2712
Telegrams: "Lewis, Reading." Full list free.

For Sale or Hire, Second-hand PORTABLE and other ENGINES of various powers by good makers.—Apply, W. ALLCHIN, Limited, Globe Works Northampton. L5

For Sale, Planing Machine, to plane 6ft. × 3ft. × 2ft. 6in.; one tool box. One do., to plane 12ft. × 3ft. 6in. × 3ft. 6in., with two tool boxes; both in first-class condition.—I. COHEN and CO., 240, Blackfriars-road, London, S.E. 29

Cranes (ALL TYPES AND POWERS). See displayed Advertisement and "Appleby's Handbook of Machinery."—JESSOP and APPLEBY BROS. (Leicester and London), Limited, 22, Walbrook, London, E.C. Sp'1803ba

For Sale.—Punch and Shear MACHINES, SALE or HIRE. Useful hand Travelling cranes.—GITTUS, Midland Ironworks, Travis-street, Manchester 8

For Sale, Punching and Shearing MACHINES, double and single ended. Large stock.—HY. GITTUS, Midland Ironworks, Travis-street, Manchester. 10

For Sale, Quite New, Made by Ruston, Proctor and Co., Lincoln, TWO 25 H.P. LOCO. MULTITUBULAR BOILERS, each complete with 30ft. Steel Chimney, Donkey Pump, Injector, and spare Firebars.—For price and particulars apply to the owner, E. S. HINDLEY, Bourton, Dorset, or to J. T. RENNIE and SONS, Durban, Natal, where the Boilers may be seen. 2166

For Sale, Radial Drilling MACHINE, 3ft. 6in. arm, in planed box bed, machine cut driving wheels, &c.; complete.—I. COHEN and CO., 240 Blackfriars-road, London, S.E. 27

For Sale, Ransomes and Rapier's MECHANICAL STOKER, fitted for 7ft. Lancashire Boiler; at work only few months.—Apply, 248, Upper Fant-road, Maidstone. P91

For Sale, S.A. Slide, Surfacing and SCREW-CUTTING LATHES.
11in. centre, 16ft. gap bed.
11in. do. 14ft. box end gap bed
21 do. 18ft. do. do
14in. do. 20ft. do. do.
TURRET LATHES, 6in. to 9in. centres.
I. COHEN and CO., 240, Blackfriars-road, London, S.E. 29

For Sale, Two Powerful Vertical BORING MILLS, spindles 4¼in. dia.; tracings on application.—JOHN H. RIDDEL, 40, St. Enoch-square, Glasgow. 2162

For Sale, Valuable Semi-portable Undertype Robey ENGINE and BOILER, double cylinders 8in. dia., equal to new.—JOHN H. RIDDEL, 40, St. Enoch-square, Glasgow. 2165

For Sale, Vertical Boilers (New), 7ft. 6in. × 3ft. 3in., 8ft. 6in. × 3ft. 6in., 9ft. × 4ft., 11ft. × 4ft., for 80 lb. CORNISH BOILERS (new), 26ft. × 6ft., 15ft. × 5ft., for 100 lb.; all passed insurance; moderate in price.—T. and R. LEES, Hollinwood, near Manchester. P221

For Sale, with Immediate delivery, a PAIR of 6 H.P. PLOUGHING ENGINES, by Weeks, of Maidstone, ready for work, good boilers and copper boxes without a blemish, together with 7-tyne CULTIVATOR and 3-furrow PLOUGH, by Howard. Net cash price £250 the lot.—Apply to the owner, MAXWELL, Rutland-road, Bedford. 2106

For Sale, with Immediate delivery, TWO 225 B.H.P. HIGH-SPEED VERTICAL COMPOUND ENGINES, by Willans and Robinson; steam pressure 160 lb., speed 350 revs. per min.; in splendid order, and can be seen working by appointment. Also several smaller engines by the same makers.—Address, 2101, Engineer Office, 33, Norfolk-street, Strand, W.C. 2101

For Sale, 10-Ton Overhead Steam TRAVELLING CRANE, 47ft. span; two gears; 100 lb. steam; seen working.—WALKER HILL and CO., Nottingham. 1941

For Sale, 30 H.P. Portable ENGINE, nearly equal to new.—H. SAMPSON and SONS, Malago Vale Ironworks, Bedminster, Bristol. 30

Hire-Purchase or for Cash.— MACHINERY of all descriptions SUPPLIED on DEFERRED PAYMENTS or for cash. New and second-hand. Write for Circular. Inspect stock, including Lathes (all sizes), Drilling Machines, Saw Benches, &c. &c.—ROWLAND G. FOOT and Co., 134, Southwark-street, London, S.E. G93

LOCOMOTIVES IN STOCK.
KERR, STUART, & CO., LTD.
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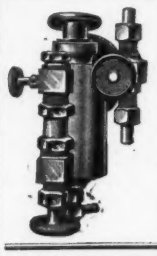

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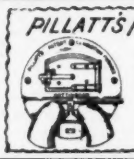

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